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Introduction

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The Preliminary Edition of the *NASA Thesaurus* (December 1967) (NASA SP-7030) is being used as the authority for the indexing vocabulary that appears in the subject index to this issue. The terminology has been modified from the *Guide to the Subject Indexes for STAR* (NASA SP-7016), the authority used for the vocabulary to indexes published prior to 1968. The *NASA Thesaurus* should be consulted for a total picture of the current indexing vocabulary including associated cross reference structure. Only the subject terms that have been selected to describe the documents abstracted in this issue appear in the subject index. Copies of the *NASA Thesaurus* may be obtained from the Clearinghouse for Federal Scientific and Technical Information or the U. S. Government Printing Office at a price of $8.50 for the three-volume set.

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02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **2383**

03 AUXILIARY SYSTEMS

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Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **2399**

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Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **2403**

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Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories. **2439**

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Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. **2450**

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Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics. **2487**

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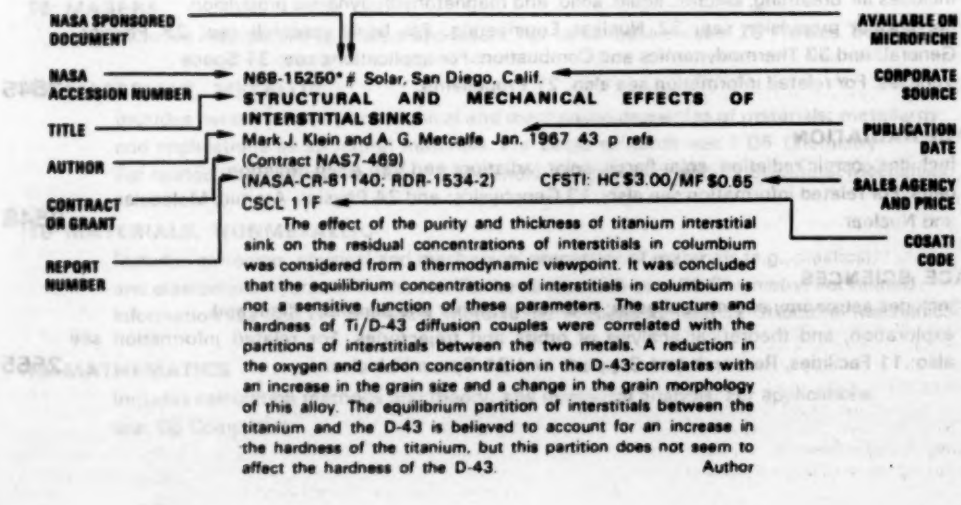
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N68-15250* # Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65
CSCL 11F
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

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Scientific and Technical Aerospace Reports

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01 AERODYNAMICS

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N68-25739# Aeronautical Research Inst. of Sweden, Stockholm.
LIFTING-LINE THEORY FOR SUBSONIC SHEAR FLOW
Bo Johansson Oct. 1967 19 p refs
(FFA-114) CFSTI: HC $3.00/MF $0.65

The method of matched asymptotic expansions is applied to the linearized problem of a wing in steady subsonic shear flow, the Mach number and other free-stream properties, varying in the spanwise direction only. The ratio of the chord of the wing to a scale length of the free-stream inhomogeneity is assumed to be small and is chosen as the perturbation parameter. A perturbation potential is introduced, and its two-term expansion is calculated. This yields a two-term expansion of the spanwise lift distribution and a one-term expansion of the induced drag distribution. As a numerical example, the case of a wing spanning a jet is considered. Author

N68-25741# Royal Aircraft Establishment, Farnborough (England).
INCREASE IN MAXIMUM LIFT OF A RECTANGULAR WING IN GROUND EFFECT BY COMBINED BLOWING AT THE WING NOSE AND AT THE TRAILING EDGE FLAP [ERHOEHUNG DES MAXIMALAUFTRIEBES EINES RECHTECKFLUEGELS IN BODENNAEHE DURCH KOMBINIERTES AUSBLASEN AN DER FLUEGELNASE UND AN DER HINTERKANTENKLAPPE]
R. Loehr Dec. 1967 38 p refs Transl. into ENGLISH from DLR-FB-64-02 Rept.
(RAE-LIB-TRANS-1270) CFSTI: $3.00

Wind tunnel measurements have been carried out on a rectangular wing with trailing edge flap situated between endplates in ground proximity. In order to increase the maximum lift by boundary layer control, the wing was equipped with blowing slots at the leading edge and at the nose of the flap. The effectiveness of combined blowing at the leading edge and the nose of the flap with respect to lift increase was tested for a flap deflection of 60° with different ground distances. The results show that for a given quantity of blowing a greater increase of maximum lift can be produced when applying combined blowing than with blowing at the flap only. Author

N68-25767*# Techtran Corp., Glen Burnie, Md.
FLOW STRUCTURE BEYOND A POORLY STREAMLINED BODY [STRUKTURA POTOKA ZA PLOKA ZA PLOKHO OBTEKAYEMYM TELOM]
L. I. Ilizarova Washington NASA May 1968 16 p refs Transl. into ENGLISH from Prom. Aerodinam. (Moscow), v. 27, 1966 p 96–110
(Contract NASw-1695)
(NASA-TT-F-11690) CFSTI: $3.00 CSCL 01A

An experimental investigation was made of the characteristics of average velocities and pressures, as well as the pulsation pressure in the wake beyond a cone and a step in a channel with two diameters. In particular, a detailed analysis is made of the zone of circulation flow immediately beyond the flat bottom of the cone. The averaged bottom pressure and its pulsations were measured, as well as the velocity profiles and pressure in the wake; the boundaries of the zone of circulation flow and zone of return flow were determined. Author

N68-25770# Royal Aircraft Establishment, Farnborough (England).
INVESTIGATIONS INTO INCREASING THE LIFT OF WINGS BY BOUNDARY LAYER CONTROL THROUGH BLOWING [UNTERSUCHUNGEN UEBER DIE ERHOEHUNG DES AUFTRIEBES VON TRAGFLUEGELN MITTELS GRENZSCHICHTBEEINFLUSSUNG DURCH AUSBLASEN]
Fred Thomas Nov. 1967 55 p refs Transl. into ENGLISH from Z. Flugwiss. (Brunswick, W. Ger.), v. 10, no. 2, 1962 p 46–65
(RAE-LIB-TRANS-1267) CFSTI: $3.00

This report gives a survey on systematic measurements on a rectangular wing with a blown flap at the trailing edge. Along the whole span of the wing air was blown out through a narrow slot over the flap in order to prevent boundary layer separation at high angles of flap deflection. The lift was increased up to $\Delta c_L \approx 5$. Force and pressure plotting measurements were carried out at Reynolds numbers between 4×10^5 and 8×10^5. Further measurements with an increased momentum coefficient (C_μ up to 1) included the region of supercirculation. To find a theoretical estimation for the minimum momentum coefficient required for preventing the flow separation, the flow phenomena in the boundary layer downstream of the blowing slot were investigated. The velocity ratio of the jet and the free flow v_j/U_∞ has a considerable influence on the characteristic boundary layer values (e.g. momentum thickness). It was possible to calculate the minimum momentum coefficient necessary to prevent boundary layer separation. Up to flap deflections of 45° these calculated values are in good agreement with the measurements. Author

N68-25861# General Electric Co., Philadelphia, Pa.
THE NON-EQUILIBRIUM AIR BOUNDARY LAYER ON A BLUNT NOSED BODY
B. Kaplan Apr. 1968 46 p refs
(Doc.-68SD227)

This report presents the results of two non-equilibrium blunt body boundary layer calculations for a sphere cone configuration. The flight conditions and geometry are 21760 fps, 150 kft., sphere cone configuration, 8.6° cone angle; two nose radii were considered 0.5 and 1.5 inches. Resulting ion distributions are shown and discussed comparatively with inviscid reacting flow field calculations and with equilibrium boundary layer calculations. It is concluded that for the conditions considered neither the equilibrium boundary layer nor the inviscid calculations can be used to predict levels of electrons over the cone frustum. Author

N68-25882*# Techtran Corp., Glen Burnie, Md.
SYMMETRIC FLOW OVER THIN GENERALIZED AXISYMMETRIC CONICAL BODIES IN A SUPERSONIC INVISCID GAS STREAM [SIMMETRICHNOYE OBTEKANIYE TONKIKH OBOBSHCHENNYKH OSESIMMETRICHNYKH KONICHESKIKH TEL SVERKHZVUKOVYM POTOKOM NEVYAZKOGO GAZA]
M. I. Gurevich and V. A. Smirnov Washington NASA May 1968 10 p refs Transl. into ENGLISH from the Publ. "Voprosy Prikladnoy Mekhaniki. Trudy Moskovskogo Instituta Inzhenerov Zheleznodorozhnogo Transporta" Moscow, Transport Press, no. 236, 1967 p 39–46
(Contract NASw-1695)
(NASA-TT-F-11693) CFSTI: $3.00 CSCL 01A

Generalized axisymmetric flow over cones is analyzed. The analysis is limited to the case where the body is within the Mach cone. An asymptotic equation for the meridianal cross section is presented for a sharp tipped cone. The solution of this equation is obtained numerically, and the resulting plots of β versus α are shown graphically. Author

N68-25883*# Techtran Corp., Glen Burnie, Md.
APPLICATION OF THE METHOD OF CHARACTERISTICS TO CALCULATIONS OF NONEQUILIBRIUM SUPERSONIC AIR FLOW PAST BLUNTED CONES [PRIMENENIYE METODA KHARAKTERISTIKH K RASCHETU NERAVNOVESNOGO OBTEKANIYA ZATUPLENNYKH KONUSOV SVERKHZVUKOVYM POTOKOM VOZDUKHA]
R. A. Gzhelyak and N. V. Dubinskaya Washington NASA May 1968 11 p refs Transl. into ENGLISH from the Publ. "Vychislitel'nyye Metody i Programmirovaniye. Chislennyye Metody v Gazovoy Dinamike Sbornik Rabot Vychislitel' Nogo Tsentra Mgu" Moscow Univ. Pres, 1967 p 197–205
(Contract NASw-1695)
(NASA-TT-F-11691) CFSTI: HC $3.00/MF $0.65 CSCL 01A

This article deals with the application of the method of characteristics to calculations of the supersonic region in the flow near a blunt body, and is based on the available data obtained from detailed analyses of dissociation and ionization processes occurring beyond a shock wave. The boundary conditions on the body and the shock wave are used in the form which coincides with the cawe of a perfect gas with constant heat capacity, because all physical and chemical processes are considered frozen when passing through a shock front. Calculations of the flow field between the body and shock wave were carried out progressively by regions bounded by the reflected characteristics. The results of calculations of the air flow past blunt cones with 1.5 cm bluntness radius at $T_\infty = 250°$, $p_\infty = 10^{-3}$ atm., $M_\infty = 13$ are presented as an illustrative example and are compared with those for an equilibrium flow with $\varkappa = 1.4$. The comparison of pressure and density distributions along blunt cones with apex angles of 10°, 0°, −10° and −20° for ideal, equilibrium and nonequilibrium flows is presented in graphical form. Author

N68-25914*# Scripta Technica, Inc., Washington, D. C.
THEORETICAL ANALYSIS OF A PROCESS OF READJUSTMENT OF THE OPERATING REGIMES OF THE STAGES IN AN AXIAL MULTISTAGE COMPRESSOR [TEORETICHESKIY ANALIZ PROTSESSA PERESTROYKI REZHIMOV RABOTY STUPENEY V OSEVOM MNOGOSTUPENCHATON KOMPRESSORE]
V. A. Stefanovskiy NASA May 1968 26 p refs Transl. into ENGLISH from the Publ. "Loptochnyye Mashiny i Struynyye Apparaty" Moscow, Mashinostr. Press, 1967 p 147–170
(Contract NASw-1694)
(NASA-TT-F-11584) CFSTI: $3.00 CSCL 10A

Generalized equations for optimum operation of individual stages of axial multistage compressors are derived which serve to restore optimum after upsets. Several equations are obtained for application to special cases. Author

N68-25916*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DYNAMIC RESPONSE OF A FAMILY OF AXISYMMETRIC HAMMERHEAD MODELS TO UNSTEADY AERODYNAMIC LOADING
Robert C. Robinson, Phillip R. Wilcox, Bruno J. Gambucci, and Robert E. George Washington Jun. 1968 42 p refs
(NASA-TN-D-4504) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The effects of boattail angle and diameter ratio on the unsteady aerodynamic loading on hammerhead launch vehicles were studied in wind-tunnel tests of 13 related dynamic models using the partial-mode model technique. The test Mach numbers ranged from 0.80 to 2.50 and the Reynolds numbers from 3.2×10^6 to 4.5×10^6 based on maximum diameter of the models. It was found that the unsteady aerodynamic loading was the result of two phenomena: buffeting due to separated flow and dynamic instability due to fluctuations between separated and attached flow. Author

N68-25919*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE MODEL WITH UNSWEPT WING AND AUGMENTED JET FLAP
David G. Koenig, Victor R. Corsiglia, and Jospeh P. Morelli (Army Aeron. Res. Lab.) Washington Jun. 1968 90 p refs
(NASA-TN-D-4610) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An investigation was made to determine the aerodynamic characteristics of a complete model equipped with an augmented jet flap. The augmented jet flap is a jet flap with the primary jet thrust increased by means of an ejector system installed in the wing trailing-edge flap. The flap was installed on the inboard part of the wing, and blown ailerons were installed on the outboard part. Tests were made with and without the horizontal tail at zero airspeed and at a dynamic pressure of 8 psf corresponding to a Reynolds number of 3.0×10^6. The measured thrust of the augmented jet flap was about 1.42 times that of the measured primary jet for flap deflections of 60° and 70° and 1.25 times the isentropic jet thrust. This ratio did not significantly decrease at forward speed. A maximum life coefficient of 6 was measured for a jet coefficient of 1.30 when the model was equipped with full-span leading-edge slats. Symmetrical aileron deflection and flap boundary-layer control were effective in producing lift increments at model attitudes below that for wing stall. With the horizontal tail installed, the variation of pitching moment with angle of attack was stable up to and including wing stall. Comparisons with jet flap test results on the basis of the same static thrust output of the systems indicated that the present augmented-jet flap configuration produced slightly higher lift increments and had more forward center-of-pressure locations. For the same isotropic primary thrust, the augmented jet flap produced 50 percent more jet force and 22 percent more lift than the jet flap. Author

N68-26023 Bolkow Entwicklungen K. G., Munich (West Germany).

DETERMINATION OF STABILITY DERIVATIVES FROM FREE-FLIGHT MEASUREMENTS ABOARD MISSILES [BESTIMMUNG VON STABILITAETSBEIWERTEN AUS FREIFLUGMESSUNG AN FLUGKOERPERN]

W. Rothmayer 29 Jul. 1966 24 p refs In GERMAN; ENGLISH summary Presented at DGRR/WGLR Ann. Meeting, Bad Godesberg, West Ger., Oct. 1966

(Rept.-66-053) CFSTI: $3.00

After a general description of free-flight techniques, two methods are derived for the determination of linear and nonlinear three-dimensional longitudinal-stability derivatives from free-flight measurements aboard of missiles. Both methods do without angle-of-attack measurements and are adapted to a standard equipment. Some results of an error-communication study by means of simulation and of real experiments are reported. Author

N68-26025 Bolkow Entwicklungen K. G., Munich (West Germany).

STATISTICAL MECHANICS OF MISSILE MOTIONS [STATISTICHE MECHANIK VON FLUGKOERPER BEWEGUNGEN]

Bertrand Weissenbach 7 Sep. 1966 13 p ref In GERMAN Presented at WGLR Meeting, Bad Godesberg, West Ger., 5 Oct. 1966

(FM-350-0) CFSTI: $3.00

Developed is a mathematical formulation for the flight analysis of a missile exposed to interference effects from a statistically determined turbulent impulse on the ideal reproducible flight trajectory. This statistical parameterization of the impulse variance or of the systems temperature field generalizes the useful work and transfers it to the vehicle motion. Information on negative entropy is related to the control system of the flying vehicle. Transl. by G.G.

N68-26104# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

ON THE CALCULATION OF UNSTEADY NONLINEAR THREE-DIMENSIONAL SUPERSONIC FLOW PAST WINGS

J. J. Kacprzynski Jan. 1968 65 p refs

(Contract F44620-67-C-0044)

(SUDAAR-339; AFOSR-68-0517; AD-668089)

A comprehensive study is made of factors influencing the accuracy of predicted thickness effects on the flow due to oscillatory motion of a sweptback wing in supersonic flight. For a delta planform with its leading edge swept at or near the Mach angle, the streamlines and velocity pattern due to thickness are found to be highly three-dimensional. Based on this observation, improvements are suggested to previous approximate second-order theories for the unsteady loading. Numerical examples are presented for 45 degree delta wings of 5% and 10% thicknesses, which indicate a substantial difference between the linearized and nonlinear lifting potential distributions. Although a greater volume of computation is needed to guarantee adequate accuracy, practical means are described for the complete numerical solution of problems of this type. Author (TAB)

N68-26301# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

VORTEX EFFECTS IN A TURBINE STAGE [O VIKHREVYKH EFFEKTAKH V TURBINNOY STUPENI]

M. Ye. Deych and Ye. Ye. Likherzak 9 Jun. 1967 18 p refs Transl. into ENGLISH from An SSSR. Izv. Energ. i Transp. (USSR), No. 1, 1966 p 109–115

(FTD-MT-67-47; AD-668511)

Experimental and calculated relationships characterizing the uneven distribution of stagnation temperatures in the viscous gas behind the vane grid of a turbine are presented. Evaluation of turbulent effects in a turbine is carried out to achieve better understanding of the actual structure (thermal and dynamic) of turbine flow. Two related problems arise in calculation of the uneven distribution of stagnation temperatures through the radius of a stage. The first problem is that of determining the method of calculation, permitting an approximation of the magnitude of the specified nonuniformity which is dependent on basic modes and geometrical parameters of a stage. The second is the insertion of related correction into the aerodynamic calculation of flow turbulence. By experimenting, several preliminary appraisals of the energy distribution behind the axial-type vane grid are made. The method proposed for evaluating stagnation temperature inhomogeneity in the nozzle grid is found entirely approximate and its error must be tested thoroughly with experiments. When experimenting with grids and high-spin stages with large M numbers, it is necessary to measure the stagnation temperature in the gap and behind the stage. Author (TAB)

N68-26344# Boeing Co., Renton, Wash.

A GENERAL METHOD FOR DETERMINING THE AERODYNAMIC CHARACTERISTICS OF FAN-IN-WING CONFIGURATIONS. VOLUME 2: COMPUTER PROGRAM DESCRIPTION Final Report

Gary R. Hink, Richard F. Gilbert, and Knut A. Sundstrom Dec. 1967 335 p refs

(Contract DA-44-177-AMC-323(T))

(USAAVLABS-TR-67-61B; AD-667981)

The report describes a digital computer program developed to study the aerodynamic characteristics of fan-in-wing configurations. The program is written in the FORTRAN IV and ASCENT languages for the Control Data Corporation 6000-series digital computers. Three basic packages are provided by the program: a geometry package produces a detailed description of the configuration, an aerodynamic package provides a theoretical solution for the potential flow about the configuration, and a boundary-layer package furnishes the boundary-layer characteristics on the wing surface. The report provides a description of the program, flow charts and segmentation structure diagrams, and input data formats. Author (TAB)

N68-26472# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SLIPPING STALL [O "SKOL'ZYASHCHEM" SRYVE POTOKA]

A. I. Pryadilov 18 Aug. 1967 17 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Energ. (Minsk), no. 5, 1963 p 67–75

(FTD-MT-24-175-67; AD-668110)

Phenomena are described of a slipping blade-tip stall in an axial 100%-reaction compressor. The slipping stall is defined as a series of adjacent local stalls that arise when $dP/d\,alpha$ becomes negative, where P is the lift force and alpha is the angle of attack. A gas leakage scheme in the stalling zone is considered, and formulas that describe the stall are developed. It is found that: (1) The rotating slipping stall is a self-oscillatory process whose energy is taken from the compressed gas; (2) The stall is caused by a sudden change in gas-flow conditions at the runner blades; (3) The analysis presented in the article permits evaluating, in the first approximation, the effect of runner rpm upon the speed of stalling and upon the flow-pulsation amplitude with a constant throttle resistance. Author (TAB)

N68-26490# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

WIND TUNNELS

I. L. Povkh 21 Jul. 1967 51 p refs Transl. into ENGLISH from the book "Aerodinamicheskiy Eksperiment v Mashinostroyenii" Moscow, Izd. Mashinostr., 1965 p 40–88, 471–480

(FTD-MT-67-07; AD-668508)

Contents: Methods of the aerodynamic experiment; Continuous flow wind tunnels; Intermittent blow-down wind tunnels; Test section and nozzle of a supersonic tunnel; Shock tunnels. TAB

N68-26566# Aeronautical Research Council (Gt. Brit.)
THE EFFECT OF INITIAL CONDITIONS ON THE DEVELOPMENT OF TURBULENT BOUNDARY LAYERS
P. Bradshaw and D. H. Ferriss 1968 37 p refs Supersedes NPL-AERO-1223; ARC-28771; See N68-12555
(ARC-CP-986; NPL-Aero-1223; ARC-28771) CFSTI: HC $3.00/MF $0.65

Calculations by a method that is believed to be reasonably accurate have been made to demonstrate how perturbations decay, in zero pressure gradient, until all that remains is a change in boundary-layer thickness. Initial perturbations in typical airfoil pressure gradients can usually be represented by an equivalent change in initial boundary-layer thickness, which produces percentage changes of the same order of magnitude in distance to separation. Author

N68-26575# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
AIR PROPERTIES AND FLOW CONDITIONS AROUND THE NOSE OF A BLUNT RADOME
Manford B. Tate Mar. 1968 46 p refs
(Contract NOw-62-0604-c)
(TG-981; AD-668145)

In order to correlate data obtained in tests on Von Karman rádomes with theoretical analyses of thermal stresses in ogive radomes, the temperature and flow conditions around the nose of a blunt radome were investigated, and the results are reported. The blunt nose causes a detached shock wave to form with a transonic flow region developed between the wave front and the nose. Approximate solutions for the velocity components in the highly nonlinear behavior are obtained, and detachment distances compared with published experimental data. Subsonic and supersonic compressible flows are studied, and the incompressible case is shown for comparison. Two numerical examples are given to illustrate the evaluation of initially unknown exponents and the computation of constants in the velocity equations. Author (TAB)

N68-26588# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON THE APPLICATION OF THE LAW OF PLANE SECTIONS TO THE DETERMINATION OF THE AERODYNAMIC FORCES ACTING ON OSCILLATING SHELLS [O PRIMENII ZADONA PLOSKIKH SECHENIY DLYA OPREDELENIYA AERODINAMICHESKIKH SIL, DEYSTVUYUSHCHIKH NA KOLEBLYUSHCHIYESYA OBOLOCHKI]
V. V. Bolotin 29 Aug. 1967 13 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR Mekhan. i Mashinostr. (USSR), no. 1, 1961 p 159–162
(FTD-HT-66-763; AD-668031)

Consideration is given to the oscillations of an infinitely long circular cylindrical shell which is elastic, around which occurs the potential flow of a compressible gas in the direction of the generators. It is shown that the approximate solution can be obtained from the exact one by a limiting process and so the approximate solution has an asymptotic character. In addition to the conditions for the limiting process, it is required that the condition of quasi-stationarity and a condition on the disturbances must be fulfilled. The bending of the shell and the aerodynamic disturbances are assumed small enough for linearized theory to apply. The equations to be solved are the equations of motion of the shell and the equation for the disturbance velocity potential. For an infinitely long cylinder, the exact solution is known. Author (TAB)

N68-26770# Boeing Co., Renton, Wash.
A GENERAL METHOD FOR DETERMINING THE AERODYNAMIC CHARACTERISTICS OF FAN-IN-WING CONFIGURATIONS. VOLUME 1: THEORY AND APPLICATION Final Report
Paul E. Rubbert, Gary R. Saaris, Michael B. Scholey, Neil M. Standen, and Richard E. Wallace Dec. 1967 298 p refs
(Contract DA-44-177-AMC-323(T))
(USAAVLABS-TR-67-61A, V. 1; AD-667980)

A general method is presented for the determination of aerodynamic characteristics of fan-in-wing configurations by means of incompressible potential-flow theory. The method is applicable to wings, flapped or unflapped, and to a wide variety of other potential-flow boundary-value problems. Arbitrary wing and inlet geometry, fan inflow distribution, thrust vectoring, angle of attack, angle of yaw, and flight speeds from hover through transition can be treated. The theoretical model is completely three dimensional, with no linearization of boundary conditions. The calculated results include pressure distributions, lift, induced drag and side force, pitching moment, rolling moment and yawing moment. The numerical potential-flow solution is obtained with source and vortex distributions on the boundary surfaces. The representation is composed of small, constant-strength source sheet panels distributed over the exterior wing surfaces, internal vortex filaments which emanate from the wing trailing edge to provide circulation and to produce the trailing vortex sheet, and a vortex lattice across the fan face and along the periphery of the fan efflux. Source and vortex strengths are obtained by satisfying boundary conditions at discrete points on the boundary surfaces. Velocities and surface pressures are calculated from the induced effects of the source and vortex distributions. Internal fan loads, based on pressure and momentum relations across the fan and an assumed fan exit flow distribution, are added to integrated wing surface pressures to determine total forces and moments on a fan-in-wing configuration. The method was programmed for use with a high-speed digital computer. Author (TAB)

N68-26828*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
REVIEW OF RECENT BALLISTIC RANGE BOUNDARY-LAYER TRANSITION WORK ON ABLATING BODIES AT AMES
Thomas N. Canning, Michael E. Tauber, and Max E. Wilkins [1967] 21 p refs Presented at the Boundary Layer Transition Specialists Study Group Meeting, San Bernardino, Calif., 11–12 Jul. 1967
(NASA-TM-X-60314) CFSTI: HC $3.00/MF $0.65 CSCL 01A

To assess the possibility of achieving extensive laminar flow on low-fineness-ratio cones during hyperbolic entry, ballistic range experiments were conducted with models that ablated at dimensionless mass transfer rates comparable to those expected for real flights at speeds up to 17 km/sec (56,000 fps). The 30° half-angle Lexan and Delrin plastic cones were recovered, and surface recessions were measured to identify laminar, transitional, and turbulent flow along the cone generators. The changes in profile revealed the local integrals of mass loss during flight. Extensive photomicrographic studies of the ablated surfaces were made, and the geometric characteristics of the patterns are described in the context of the boundary layers thought to be responsible for their production. A possible relationship is noted between the observed markings and strong streamwise vortices in boundary layers found by other investigators. M.G.J.

N68-26935# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STABILITY OF A THREE-LAYER ORTHOTROPIC PLATE IN A SUPERSONIC GAS FLOW [OB USTOYCHIVOSTI TREKHSLOYNOY ORTOTROPNOY PLASTINKI V SVERKHZVUKOVOM POTOKE GAZA]
Zh. Ye. Bagdasaryan 29 Aug. 1967 18 p refs Transl. into ENGLISH from Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk (Erevan), v. 14, no. 5, 1961 p 21–30
(FTD-HT-66-764; AD-668121)

The report attempts to solve the problem of non-linear flutter of three-layer rectangular plates, streamlined by a supersonic gas stream with a zero angle of attack. The layers are symmetrical w.r. to the neutral plane and the materials obey a generalized Hooks law. Normal displacements were assumed to be comparable with the thickness of the plate. A system non-linear differential equations was given together with the expression for a transverse load, and boundary conditions. An approximate solution was assumed to be trigonometric and, on substitution, the original equations were shown to reduce to a non-linear system of two equations in dimensionless variables, for the case of one-sided streamlining with different stream velocities. The periodic solution near the critical value was sought by the method of successive approximations and the amplitude and frequency of established flutter vibrations were found by the Bubnov-Galerkin method. The amplitude of second approximation was also obtained. Two possible cases were discussed and a numerical example was given. The conclusions reached were that critical flutter velocity found by the above method is significantly smaller than that found from the classical theory, and that the difference between two values increases with the value of h1/a, where h1 is thickness of the plate and a is length of the plate. TAB

N68-26955# Northrop Corp., Hawthorne, Calif.
A NUMERICAL PROCEDURE FOR DETERMINING THE COMBINED VISCID–INVISCID FLOW FIELDS OVER GENERALIZED THREE-DIMENSIONAL BODIES. VOLUME 1: DISCUSSION OF METHODS AND RESULTS, AND INSTRUCTIONS FOR USE OF COMPUTER PROGRAM Final Report, 1 Jul. 1962–1 Jun. 1967
S. A. Powers, A. F. Niemann, Jr., and J. Der, Jr. Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Dec. 1967 178 p refs
(Contract AF 33(657)-8673)
(NOR-67-91; AFFDL-TR-67-124, V. 1; AD-668772)

The report describes the methods and computer programs developed for determining the combined viscid-inviscid flow fields over generalized three-dimensional bodies. The inviscid flow field is determined by a three-dimensional method of characteristics program, while the laminar boundary layer is determined by a three-dimensional explicit finite difference method. The complete program, which can treat either ideal or real gas flows, is highly automated and provides many optional paths of analysis. This volume discusses the methods used in calculating both the viscid and inviscid flow fields, and the application of these methods by means of digital computer. Results are given for the viscid and inviscid flows over a delta wing, and for the viscid flow over an ellipsoid. The results are shown to be in good agreement with experimental results. Author (TAB)

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N68-25717*# Martin Co., Denver, Colo.
THERMAL PROTECTION SYSTEM X-15A-2 Design Report
A. B. Price 12 Jan. 1968 287 p Revision 1
(Contract NAS4-1212)
(NASA-CR-82003; ER-14535) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An ablator thermal protection system designed to provide protection to X-15A-2 research aircraft for missions to Mach 7.4 is described. The system is designed around the use of a room temperature vinyl cure, elastomeric silicone-based ablator material with a viscosity suitable for spray application. A spray coating of the material, of varying thickness, constitutes the primary ablator application on the aircraft. Local design details and environmental requirements necessitate specialized treatments and materials on certain areas such as leading edges and high bearing load areas. A fiber reinforced elastomeric ablator, and inserts of a load carrying material are utilized in those areas where environmental requirements exceed the performance capabilities of the sprayable ablator. To provide the relatively friable ablators with a degree of protection from damage and to minimize the generation of particulate contamination, a LOX-compatible, tenacious, tear-resistant wear layer is used over the ablator application. It is further pointed out that the ablation system must not impede or affect the function or performance of the aircraft systems, and the materials must be easily applied and removed to minimize system turn around time requirements. A.L.

N68-25745*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE CONVERSION OF THE ROTOR WING AIRCRAFT
R. J. Huston and J. P. Shivers Washington 1967 30 p refs Presented at the AGARD Specialist Meeting on Fluid Dyn. of Rotor and Fan Supported Aircraft at Subsonic Speeds, Goettingen, W. Ger., 11–13 Sep. 1967
(NASA-TM-X-60448) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The principal problem during conversion from wing-borne to rotor-borne flight is the possibility of a large attitude disturbance during the first revolution of the rotor due to an oscillation of the lift center of pressure in a longitudinal and lateral direction at a frequency that is simply the number of blades multiplied by the rotor rotational speed. Wind tunnel tests indicate that large-amplitude cyclic pitch is one means of eliminating the source of the disturbance for a three-bladed rotor/wing aircraft. In addition, the selection of four blades on a rotor/wing aircraft may so substantially reduce the disturbing moments that cyclic pitch is not required to eliminate the moments. An analytical study shows that the disturbance may also be reduced by a rapid initial rotor acceleration or by an oscillation of the horizontal tail surfaces (elevons) at the frequency of the lift center-of-pressure oscillation. However, simultaneous use of the elevons for longitudinal and lateral control will increase the minimum conversion speeds. Author

N68-25759# Aeronautical Research Inst. of Sweden, Stockholm.
STATISTICAL MAGNIFICATIONS OF SONIC BOOMS BY THE ATMOSPHERE
Robert Dressler and Nils Fredholm 1966 21 p refs
(FFA-104; TDCK-48771) CFSTI: HC $3.00/MF $0.65

The long sonic-boom path through the atmosphere can experience sufficient variations in wind-temperature gradients to cause large departures in overpressure Δp from its nominal value. We investigate statistical scatter in Δp-magnification M due to large-scale atmospheric effects of wind and temperature for steady-state cruise. Justification is made for use of linear-theory for pressure ratios in the far-field. The geometrical acoustic approximation is also justified; Fourier transforms of N-waves show, by analogy with optics, that the accuracy is sufficient for statistical purposes. For cruise at Mach number 2.2 and 50,000 feet, a Monte-Carlo analysis by computer obtains relative overpressures at ground for 480 random atmospheres. Results show that the nominal value is the median of M, not the mean, which is considerably higher. The calculated distribution for M is log-normal between values 1.3 and 3.0. On the average, a Δp-magnification at least twice the peak nominal occurs in cruise once in 110 flights, and three times occurs once in 500 flights. Extrapolation indicates that once in 2000 flights a magnification at least four times would occur. Author

N68-25792# Boeing Co., Seattle, Wash.
DYNAMIC MOTIONS OF AIRCRAFT—SURVEY AND INTRODUCTION
Clarence L. Flora [1966] 25 p refs Presented at the AGARD Flight Mech. Panel Specialists Meeting—Stability and Control, Cambridge (England), 20–23 Sep. 1966

The large size and slender configuration of forthcoming transport aircraft will result in characteristics significantly different from those of previous airplanes. In low-speed flight the dynamic response to the flight controls will be characterized by sluggishness and undesirable coupling effects and in high-speed flight by large contributions from the elastic response of the structure. The low-speed longitudinal characteristics are shown to be degraded by "short-coupled" pitch control surfaces, and direct lift control is examined as an alternate to conventional pitch control for flight path control in the vertical plane. Low-speed lateral-directional control is examined from the aspect of the turn coordination characteristics produced by inertially slender configurations with high principal axis inclinations. High-speed longitudinal control of a flexible airplane is examined in the light of current design requirements and an example given of the problems encountered in providing adequate overall airplane response without excessive excitation of the aircraft structural vibration modes. Author

N68-25801# Aeronautical Research Inst. of Sweden, Stockholm.
ATMOSPHERIC MAGNIFICATION OF SONIC BOOMS IN THE OKLAHOMA TESTS
Bo K. Lundberg, Robert F. Dressler, and Sven Lagman Jun. 1967 17 p refs
(FFA-112) CFSTI: HC $3.00/MF $0.65

By subjecting the Oklahoma City test data to further analysis, some new results of significance have been obtained. Distribution curves must first be adjusted to actual median values produced by the flights, and an absolute magnification calculated from the reported local magnifications. Then two clear trends can be exhibited: size of magnifications depends upon cruising altitude, and superbooms tend to occur at the carpet edges, in agreement with theory. The concepts of total wave energy and transferred energy and the magnifications are discussed, with specific reference to large SST's. Author

N68-25817*# Colorado Univ., Boulder.
OPTIMUM MANEUVERS OF HYPERVELOCITY VEHICLES
A. Busemann, N. X. Vinh, and G. F. Kelley Washington, D. C. NASA Jun. 1968 67 p refs
(Grant NGR-06-003-033)
(NASA-CR-1078) CFSTI: HC $3.00/MF $0.65 CSCL 01B

This report presents the analytical solutions of the problem of optimum maneuvering of a glide vehicle flying at hypervelocity regime. The investigation is based on the approximation of Allen and Eggers, namely along the fundamental part of a reentry or ascent trajectory the aerodynamic forces greatly exceed the components of the force of gravity in the directions tangent and normal to the flight path. The problem consists of finding an optimal control law for the lift program such that the final velocity or the final altitude is maximized. As applications, the problem can be viewed as bringing the vehicle to the best condition for interception, or penetration, or making an evasive maneuver. If the range is not constrained, the solutions are obtained in closed forms. If the lift control is bounded, then bounded control is optimal whenever it is reached. The switching sequences for different cases are discussed and it is shown that there are at most two switchings. When the range is also prescribed the problem consists of integrating a second order nonlinear system. Using Poincaré's series expansions technique, an approximate solution is obtained for the case of optimizing the final velocity with a slightly constrained range. Author

N68-25834#
COCKPIT DISPLAYS
D. J. Walters 1966 27 p Presented at the AGARD Specialists Meeting on Stability and Control, Cambridge, Engl., 20–23 Sep. 1966

The problem of integrating the displays in a cockpit is described. The three basic forms of information presentation i.e. head-up, head-down electro-mechanical, and head-down electronic are described and their inherent capabilities and limitations discussed. This leads to the expression of the author's view that a correct balance of director, processed situation, and basic situation information can be obtained where each type of instrument is used to best advantage. Author

N68-25879*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
V/STOL SESSION INTRODUCTORY AND REVIEW PAPER
John P. Campbell 6 Apr. 1967 26 p refs Presented at the Intern. Congr. of Subsonic Aeron., New York, 3–6 Apr. 1967
(NASA-TM-X-59740) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An introductory and review paper on propeller, fan, and jet V/STOL aircraft types which was presented at the International Conference of Subsonic Aeronautics is reported. Discussed are the following four basic characteristics of V/STOL aircraft: (1) high power requirements in hovering flight; (2) the vertical slipstream for hovering flight; (3) the inherent deficiencies in aerodynamic stability and control in hovering and low speed flight; and (4) the special provisions made for performing the conversion from the hovering to the cruise configuration. Also briefly discussed are fundamental relationships between the lift and power requirements for conventional and V/STOL aircraft, handling qualities, ground effects, and noise. Included is an analysis of V/STOL accident potential as compared with experimental and research aircraft. S.C.W.

N68-25886*# Martin Co., Denver, Colo.
FULL SCALE FLIGHT TEST REPORT, X-15A-2 ABLATIVE THERMAL PROTECTION SYSTEM
A. B. Price 23 May 1968 175 p Revised
(Contract NAS4-1212)
(NASA-CR-82004; MCR-68-15, Rev. 1) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The ablative thermal protection system designed for the X-15A-2 aircraft was qualified through flight test and performance analysis. The procedures formulated for applying, partially refurbishing, and removing the ablation system were validated and an overall evaluation of the ablator's condition after flight test exposures of Mach 5.0 and 6.7 are presented. An analytical correlation of the observed ablator performance was conducted to verify predictability and gain confidence in the ablator system's capabilities as the environmental envelope is expanded to the operational limits of the flight vehicle. Potential problem areas are identified and their methods of resolution are presented. Author

N68-25889*# Martin Co., Denver, Colo.
APPLICATION AND REFURBISHMENT PROCEDURES X-15A-2 THERMAL PROTECTION SYSTEM
J. T. Thompson and A. B. Price 23 May 1968 111 p Revised Supersedes ER-14539, Mar. 1967
(Contract NAS4-1212)
(NASA-CR-96000; ER-14539, Rev. 1) CFSTI: HC $3.00/MF $0.65 CSCL 01C

This process manual establishes the materials, equipment, protection and application procedures and controls to be utilized for the application, repair and refurbishment of the Martin Marietta ablative thermal protection system for the X-15A-2 aircraft as described in the Design Report, ER14535. The operations and requirements will provide ablator protection for the X-15A-2 aircraft for the Mach 7.4 design trajectory defined in ER 14535. The scope of operations required for turn around of the aircraft thru the ablator application and refurbishment cycles can be divided into a number of separate, though related, categories and/or processes.

This manual is so divided, and presents the requirements and methods of each sub-division in their entirety. Such an arrangement eliminated duplication of instruction, but does not permit strict adherence to chronological sequencing. Cross referencing, therefore, is employed between report sections to provide the sequential continuity of the total ablator operation. Author

N68-25894# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.

ON THE CONSTRUCTION OF SINGLE-STAGE ROCKET AIRPLANES FOR GLOBAL AIR COMMERCE [ZUR AUSLEGUNG EINSTUFIGER RAKETENFLUGZEUGE FUER DEN GLOBAL FLUGVERKEHR]

B. Neumann Jul. 1967 85 p In GERMAN

(TUB-IR-4/1967) CFSTI: HC $3.00/MF $0.65

Evaluated is the possibility of employing single booster rocket vehicles as fast global passenger transporters in flights over 6000 km after the year 1980. The performed analysis determines flight performances and weights for a single booster rocket vehicle; cost estimates and operational aspects are used to establish vehicle dimensions and capabilities for optimal economic use. It is concluded that the single booster rocket vehicle is economically feasible as a means for transportation. Transl. by G.G.

N68-25912# Metaalinstituut TNO, Delft (Netherlands).

RESEARCH ON THE CAUSES OF THE BREAKING OF A MAIN WHEEL OF A "S-2A" AIRCRAFT [ONDERZOEK NAAR DE OORZAAK VAN HET BREKEN VAN EEN HOOFDWIEL VAN EEN "S-2A"-VLIEGTUIG]

P. Breedveld 19 Dec. 1967 8 p In DUTCH

(TDCK-49845; M67-948)

Discussed are the results of a macroscopic and microscopic investigation into the causes of a wheel fracture which occurred while the aircraft was rolling during an attempted takeoff. The wheel is made of the alloy AZ 81, a magnesium alloy with 7.5% Al, 0.7% Zn, and 0.15% Mn. Comparative tests were also conducted with two additional wheels that were intact. The fracture is found to have been caused by stress corrosion. Transl. by K.W.

N68-25987# Cornell Aeronautical Lab., Inc., Buffalo, N. Y. Flight Research Dept.

RECENT EXPERIENCE WITH IN-FLIGHT SIMULATION

Waldemar O. Breuhaus [1966] 44 p refs Presented at the AGARD Specialists' Meeting on Stability and Control, Cambridge, Engl., 20-23 Sep. 1966

Specialized control systems installations have made possible a wide range of flying qualities within a single aircraft. This has led to in-flight simulation of various flight conditions. The early development of in-flight simulation is discussed, and comparisons of several ground-based and in-flight simulation programs are made. Application of in-flight simulation to two programs conducted to investigate the influence of speed-thrust instability on flying qualities is discussed. It is shown that for the landing maneuver, the differences between the tasks pertinent to different airplanes can lead to different flying qualities requirements. Results from in-flight simulation programs are presented to indicate usual magnitudes of variance of pilot ratings during flying qualities investigations. Effects of turbulence on in-flight simulation are discussed, and use of in-flight simulation as an instructional aid at test pilot schools is mentioned. Author

N68-26019# Department of Transportation, Washington, D. C. Office of Noise Abatement.

FEDERAL AIRCRAFT NOISE ABATEMENT PROGRAM Summary Status Report

1 Apr. 1968 27 p refs

An overview is presented on the efforts being undertaken to resolve the conflict existing between the producers of air transportation service and the people living or working in communities near airports. It is reported that an analysis of land use information for the noise exposure forecast areas, in the environs of Kennedy, O'Hare, and Los Angeles airports, has provided a reliable definition of the noise exposure problem that may be expected in the future. Summary data are included on studies being conducted to determine cost allocation rationale; develop physical, psychoacoustic, and sociological research techniques for use as a basis in evolving quantitative noise evaluation methods and standards; reduce engine noise; change landing approach procedures; standardize noise abatement takeoff procedures; develop practicable approaches to a coordinated Federal program for stimulating airport community development in directions which would tend to anticipate aircraft noise problems. A report bibliography is included, along with a list pf FAA publications relating to human response to aircraft noise and sonic boom. M.G.J.

N68-26024# Technische Univ., Berlin (West Germany).

DEVELOPMENT OF A SINGLE-STAGE ROCKET-DRIVEN AIRCRAFT FOR GLOBAL AIR TRAFFIC [ZUR AUSLEGUNG EINSTUFIGER RAKETENFLUGZEUGE FUER DEN GLOBALEN FLUGVERKEHR]

Bernfried Neumann (Ph.D. Thesis) Apr. 1967 159 p refs In GERMAN

CFSTI: HC $3.00/MF $0.65

Analyzed are work loads and weights of single stage rocket driven aircraft for intercontinental traffic. Operational and cost estimates of various aircraft structures and performance parameters are developed for optimal economic results. It is concluded that under certain circumstances the single-stage rocket propelled aircraft is economically feasible. Transl. by G.G.

N68-26058# Boeing Co., Renton, Wash. Commercial Airplane Div.

OPERATIONAL ANALYSIS OF TIME-FREQUENCY COLLISION AVOIDANCE SYSTEMS

Alex S. L. Nagy 1968 93 p refs

(D6-19535; AD-668163)

The purpose of the work documented in this report was to develop a capability to evaluate collision avoidance systems (CAS) and to perform an operational analysis on a time-frequency collision avoidance system using this capability. Answers were sought for the following questions: (1) Given a certain threat geometry, how effective is the CAS in providing safe separation of the aircraft. (2) How do measurement errors degrade the performance of the CAS for a given encounter. (3) To what extent do alarms propagate vertically in high traffic density environments such as holding patterns. Author (TAB)

N68-26159# Air Transport Association of America, Washington, D. C.

STANDARD METHOD OF ESTIMATING COMPARATIVE DIRECT OPERATING COSTS OF TURBINE POWERED TRANSPORT AIRPLANES

Dec. 1967 13 p refs Modification to the 1960 Revision of the Air Transport Assoc. Standard Method of Estimating Comparative Direct Operating Costs of Transport Airplanes

A standardized method of estimating operating costs of turbine powered transport aircraft is discussed. A detailed direct operating cost equation, and other required formulas, are presented. It is pointed out that the objective of estimating operating costs is to provide a ready means for comparing the operating economics of competitive airplanes under a standard set of conditions. It is further emphasized that these formulas are designed to provide a basis of comparison between differing types of airplanes and should not be considered a reliable assessment of actual true value of the operating costs experienced on a given airplane. A.L.

N68-26194*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

HOT-GAS INGESTION AND JET INTERFERENCE EFFECTS FOR JET V/STOL AIRCRAFT

Alexander D. Hammond and H. Clyde McLemore Washington 1967 31 p refs Presented at the AGARD Flight Mech. Panel Meeting, Goettingen, W. Ger., 13–15 Sep. 1967

(NASA-TM-X-60449) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Tests were conducted in the Langley full-scale tunnel and the 7- by 10-foot tunnels to investigate three problems unique with jet-powered VTOL aircraft. These problems are: (1) hot-gas ingestion; (2) aerodynamic suck-down; and (3) jet interference in transition flight. The tests concerning hot-gas ingestion were conducted on a large-scale fighter-type model which had a J85 turbojet engine mounted in the fuselage to provide the model exhaust and inlet flow. Results of the hot-gas ingestion tests showed that aircraft configuration, particularly the exhaust and inlet arrangement, and surface winds can greatly alter the ingestion. Deflecting the engine exhaust gases rearward and making rolling take-off to stay ahead of the hot-gas field appears to be one solution to the hot-gas ingestion problem. Another solution is to design the aircraft so that components such as wings shield the engine inlets from the direct path of the hot exhaust gases. Tests with small-scale models have shown that design principles useful for reducing aerodynamic jet interference on ground and during transition are in conflict with those that should be used to reduce hot-gas reingestion. Author

N68-26243# Royal Aircraft Establishment, Bedford (England).

LOW-SPEED INVESTIGATIONS USING FREELY-FLYING MODELS

P. L. Bisgood [1966] 15 p refs Presented at AGARD Specialists Meeting on Stability and Control

CFSTI: HC $3.00/MF $0.65

The freely-flying model is potentially a valuable research tool for the study of low-speed flight behaviour and, in some cases, offers distinct advantages over other methods of investigation. Some of these potentialities are discussed herein. Examples are given of the application of free-flight model techniques to the study of the low-speed flight characteristics of a family of slender-wing aircraft, and the results obtained are compared with those from other sources. Shortcomings of the techniques are considered, together with future developments. Author

N68-26277*# National Aeronautics and Space Administration, Washington, D. C.

NASA RESEARCH EXPERIENCE ON JET AIRCRAFT CONTROL PROBLEMS IN SEVERE TURBULENCE

Richard J. Wasicko [1966] 27 p refs Presented to the Flight Mech. Panel of AGARD, Cambridge (England), 20–23 Sep. 1966

(NASA-MT-X-60179) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Factors associated with five jet upsets involving swept-wing jet transports are presented, and the elements of an intercenter NASA research program on the rough air control problem are reviewed. Described are quantitative data on factors which contribute to the upsets and the piloting techniques which could cause flight path control difficulties. Discussed are swept-wing jet transport handling qualities, flexible vehicle cockpit acceleration environment and its effect on pilot performance, simulator studies of aircraft control in turbulence, and flight tests of upset-recovery maneuvers. It is shown that both the oscillatory and pure divergent initial phases of jet upsets similar to those experience in airline operations could be achieved in the simulator. Flight tests of one transport revealed that supplemental recovery control in addition to the maximum elevator deflections available was required for rapid upset recovery if the stabilizer remained mistrimmed during the upset. Author

N68-26329# British Aircraft Corp., Preston (England).

AUTO-AERODASTIC MODE COUPLING, A COMPARISON OF PREDICTED AND ACTUAL CHARACTERISTICS

G. J. Evans and B. J. Beele [1966] 29 p Presented at the AGARD Flight Mech. Panel Stability and Control Session, Cambridge (England), Sep. 1966

CFSTI: HC $3.00/MF $0.65

Providing elastic mode stability for automatically controlled aircraft has become more problematic due to trends in control system and aircraft structural design. An approach to predicting the extent of the problem and devising a solution is summarized. Several methods of obtaining the information necessary to confirm that the paper-designed control system is suitable in practice are compared. Actual experience with these methods was confined to a series of ground tests carried out as a preliminary to the flight program, and some results are presented. The tests demonstrated shortcomings in the mathematical model employed in the theoretical studies and necessitated modifications to the automatic flight control system. Some suggestions for improving the adequacy of mathematical models and test procedures are given. Author

N68-26330 British Aircraft Corp., Preston (England).

EXPERIENCE WITH SHINBROT'S METHOD OF TRANSIENT RESPONSE. ANALYSIS FOR THE EXTRACTION OF STABILITY AND CONTROL DERIVATIVES

B. R. A. Burns [1966] 45 p refs Presented at the AGARD Flight Mech. Panel Specialists Meeting—Stability and Control, Cambridge (England), Sep. 1966

The use of transient response tests and analyses for extracting stability and control derivatives from flight records of autostabilized aircraft is discussed, and the reasons for adopting Shinbrot's method are explained. Shinbrot's technique and its application is discussed, including representation of instrumentation dynamic response in the equations of motion. Preliminary experience with the method, applied to analyze highly damped responses of a Meteor and a Dove with sensitive test instrumentation, is described. When all terms in the equations of motion were treated as unknowns, the results were unreliable; they were good only when the number of unknowns was reduced in each equation. By using different sections of the record for evaluating different derivatives, the complete set of derivatives was extracted. Subsequent records were therefore analyzed in stages, evaluating control, stiffness, and damping in turn. Simulated tests with nonlinear stability effects are described. The method was also applied to flight records of a supersonic military aircraft. The importance of instrumentation accuracy and dynamic response is pointed out, and the effects of errors are illustrated. K.W.

N68-26368# Bunker-Ramo Corp., Canoga Park, Calif.

ARMY AIRCRAFT VOICE-WARNING SYSTEM STUDY Final Report, 10 Aug. 1967–10 Jan. 1968

James E. Brown, Carmine M. Bertone, and Richard W. Obermayer Aberdeen Proving Ground, Md. Human Eng. Labs' Feb. 1968 230 p refs

(Contract DAA05-68-C-0025(X))

(G0131-8U1; TM-6-68; AD-667924)

The report describes an analytical study that was intended to serve as a basis for the application of voice-warning systems (VWS) for the UH-1B and UH-1D (Huey), AH-1G (Cobra), CH-47 (Chinook), CH-54 (Skycrane), and OV-1 (Mohawk). The following problems of installing a VWS in these Army aircraft were studied: (1) the identification and selection of messages for maximum effectiveness; (2) the determination of priority sequences; and (3) the integration of the VWS into existing cockpits. The study involved the collection of basic data and the conduct and validation of mission analyses, operational sequence diagrams, task analyses, aircraft configuration analyses, pilot opinion surveys, and Army aircraft accident analyses. In the report, priority sequences are derived for all major emergencies for the six vehicles; further analytical effort is described which reduced the list to 20 messages

for inclusion in the VWS. For each aircraft, 2 lists of 20 messages are proposed; one list assumes additional sensors, while the second assumes the current sensor system. Recommendations are made for message structure and content, priority sequences, integration of the VWS with the current visual-warning system, general sensor requirements, interlocking between VWS messages, and other related considerations. Author (TAB)

N68-26409# Bell Helicopter Co., Fort Worth, Tex.
A STUDY OF THE VALIDITY OF GROUND-BASED SIMULATION TECHNIQUES FOR THE UH-1B HELICOPTER
John H. Emery, Walter G. O. Sonneborn, and Claude B. Elam Dec. 1967 83 p refs
(Contract DA-44-177-AMC-463(T))
(BHC-299-099-350; USAAVLABS-TR-67-72; AD-667988)

The work explored the characteristics of some simulator and flight data which were collected in a UH-1B helicopter and a ground-based simulated version of the same. Analytical treatments are described and applied to these data. They are autocorrelation and cross correlation functions, pilot error and pilot efficiency. Results are reported on the effectiveness of certain simulator variables and performance measurement techniques. Author (TAB)

N68-26416# Bell Aerosystems Co., Buffalo, N. Y.
STUDY, SURVEY OF HELICOPTER AND V/STOL AIRCRAFT SIMULATOR TRAINER DYNAMIC RESPONSE. VOLUME 2: DYNAMIC RESPONSE CRITERIA FOR V/STOL AIRCRAFT FLIGHT TRAINERS Final Report
H. G. Streiff Orlando, Fla. Naval Training Device Center May 1967 187 p refs
(Contract N61339-1753)
(NAVTRADEVCEN-1753-2; AD-668006)

The results of a study to determine the dynamic response criteria for V/STOL aircraft simulator trainers are presented. The fundamentals of V/STOL dynamics, control, and simulation within the various V/STOL flight regimes are described. Difficulties likely to be encountered in developing an adequate V/STOL aircraft simulation are also presented. Methods and procedures for determining the accuracy to which specific dynamic response parameters must be simulated are presented, and based upon these, simulation tolerances are developed for each significant handling qualities parameter in each flight regime. The dynamic attributes of the pilot-aircraft combination with regard to each specific parameter are discussed. A detailed description of various V/STOL aircraft equations of motion, transfer functions, and modes of motion is included and the practical limitations of various methods and procedures for programming the equations of motion for piloted flight simulation purposes are discussed. Author (TAB)

N68-26445# Army Aeromedical Research Unit, Fort Rucker, Ala.
TINTED WINDSCREENS IN U. S. ARMY AIRCRAFT
John K. Crosley Mar. 1968 18 p refs
(USAARU-68-7; AD-667960)

A spectrophotometric analysis was performed on the tinted windscreen of the U. S. Army AH-1G helicopter. The results of this test, considered in conjunction with the conclusions of other researchers working with both aircraft and automobile tinted windshields, have led to the recommendation that no tinted media should be positioned between the pilot and his normal field of view during heavy overcast days, at twilight, or at night. Author (TAB)

N68-26691*# Dynamic Science Corp., Monrovia, Calif.
A STUDY OF AIRCRAFT FIRE HAZARDS RELATED TO NATURAL ELECTRICAL PHENOMENA Final Report, Jun. 1966-Jul. 1967
Frank L. Kester, Melvin Gerstein, and J. A. Plumer (GE, Pittsfield, Mass.) Washington NASA Jun. 1968 128 p refs Prepared jointly with GE, High Voltage Lab., Pittsfield, Mass.
(Contract NASw-1416)
(NASA-CR-1076; SN-9000) CFSTI: HC $3.00/MF $0.65 CSCL 01B

The problems of natural electrical phenomena as a fire hazard to aircraft are evaluated. Assessment of the hazard is made over the range of low level electrical discharges, such as static sparks, to high level discharges, such as lightning strikes to aircraft. In addition, some fundamental work is presented on the problem of flame propagation in aircraft fuel vent systems. This study consists of a laboratory investigation in five parts: (1) a study of the ignition energies and flame propagation rates of kerosene-air and JP-6-air foams, (2) a study of the rate of flame propagation of n-heptane, n-octane, n-nonane, and n-decane in aircraft vent ducts, (3) a study of the damage to aluminum, titanium, and stainless steel aircraft skin materials by lightning strikes, (4) a study of fuel ignition by lightning strikes to aircraft skins, and (5) a study of lightning induced flame propagation in an aircraft vent system. Author

N68-26700# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
COMPARISON OF LONGITUDINAL STABILITY CHARACTERISTICS OF THREE TILT-WING VTOL AIRCRAFT DESIGNS
R. A. Curnutt and H. C. Curtiss, Jr. Jan. 1968 102 p refs
(Contract DA-44-177-AMC-8(T))
(USAAVLABS-TR-66-64; Rept.-794; AD-667983)

Experimental values of the longitudinal stability derivatives of three tilt-wing VTOL aircraft configurations as obtained from tests of several models are presented. Results from the NASA full-scale wind tunnel at Langley Field, the Princeton track, the LTV Aerospace Corporation wind tunnel and flight test are included. An analysis is included which utilizes root-locus and analog computer studies to compare the characteristic roots and transient response of the aircraft as the longitudinal derivatives are varied within the range exhibited by these data. Trim conditions at wing incidences from 20 to 90 degrees are considered. The three configurations included in the analysis were found to exhibit quite similar stability characteristics in the low-speed regime. Good correlation was found to exist between NASA wind tunnel data and Princeton Dynamic Model Track data for the VZ-2 aircraft. Consideration is given to the importance of various derivatives in determining the response characteristics. A large number of analog computer traces are included, showing variations in response characteristics caused by changes in individual derivatives. Author (TAB)

N68-26705 Royal Aircraft Establishment, Bedford (England).
RESULTS OF FLIGHT TESTS ON A SLENDER WING LOW SPEED RESEARCH AIRCRAFT (H.P. 115)
P. L. Bisgood [1967] 26 p refs Presented at 28th Meeting of AGARD Flight Mech. Panel
CFSTI: $3.00

Flight tests to determine the stability derivatives of a slender-wing, low-speed aircraft are described along with miscellaneous supporting tests. The results are compared with wind tunnel measurements in which the level of agreement is satisfactory. The more important handling qualities are described and are compared with existing criteria and with a ground-based simulation of the test aircraft. Contrary to expectation the aircraft's handling qualities proved remarkably docile and free from serious problems. Author

N68-26747# Hydronautics, Inc., Laurel, Md.
MOTIONS OF A FLOAT-SUPPORTED AIRCRAFT IN A SEAWAY
R. A. Barr, R. Altmann, and K. K. Wong Sep. 1967 122 p refs
(Contract Nonr-4769(00))
(TR-513-3; AD-668171)

An experimental investigation of three vertical float configurations was carried out and the results compared with theoretical predictions of the motions. The models considered correspond to: The A2 aircraft configuration considered by Wong in head seas; the A2 configuration in beam seas; and a configuration identical with the A2 configuration in beam seas but having tapered or flared floats. It was thus possible to compare the response for three configurations each having significantly different responses. Calculations of the heave, pitch (roll) and surge (sway) response were made using the non-linear methods developed by Barr and Martin. The measured heave and surge response are found to be in fairly good agreement with the theoretical predictions. The measured and predicted pitch (roll) responses are not in good agreement, although fair agreement was obtained for head seas by a modification of the estimated plate drag coefficient. For both roll and heave, the measured response was greater with tapered than with cylindrical floats. Further experimental investigation of float and damping plate forces and non-linear effects are needed to obtain improved predictions of response, particularly for pitch (roll).
Author (TAB)

N68-26852# National Academy of Sciences—National Research Council, Washington, D. C.
GENERATION AND PROPAGATION OF SONIC BOOM
Clarence S. Howell et al Oct. 1967 30 p

The sonic boom research now underway in government, aerospace industry, and universities is summarized, and the adequacy of such work in the light of the current state of knowledge is assessed. Background material related to the understanding of the generation and propagation of the sonic boom is discussed, and some problem areas and technical deficiencies of sonic boom research are discussed. The adequacy of current research activities was assessed in relation to seven areas: (1) analytical methods of predicting shock wave characteristics at the source, (2) understanding of the near-field region, (3) propagation of shock waves through atmospheric layering, (4) propagation of shock waves through turbulence adjacent to the ground, (5) topographical effects, (6) effects of acceleration and maneuver, and (7) aircraft design studies to minimize sonic boom effects. B.S.D.

N68-26853*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SUMMARY OF GOVERNMENT RESEARCH PROJECTS ON SONIC BOOM GENERATION, PROPAGATION AND MINIMIZATION
Laurence K. Loftin *In* NAS-NRC Generation and Propagation of Sonic Boom Oct. 1967 6 p (See N68-26852 15-02) CSCL 01B

Government research projects on sonic boom generation, propagation and minimization are summarized with attention focused on current research activities being conducted by NASA. These include sonic boom generation in the supersonic and hypersonic speed regions, boom propagation and atmospheric effects, and sonic boom minimization. Specific project activities on each of these broad areas are listed with the purposes and objectives of each. B.S.D.

N68-26854# Boeing Co., Seattle, Wash.
CURRENT SONIC BOOM RESEARCH IN THE AEROSPACE INDUSTRY OF THE UNITED STATES
Clarence S. Howell *In* NAS-NRC Generation and Propagation of Sonic Boom Oct. 1967 4 p (See N68-26852 15-02)

Current sonic boom research being conducted within the United States aerospace industry is summarized. A survey of nine major companies in the aerospace industry shows that relatively little sonic boom research is underway at the present time. The survey showed that the companies who have an interest in supersonic aircraft or missiles have developed a capability to predict sonic boom characteristics. It also illustrated that the present analytical methods for predicting, and through design, minimizing the generation sonic boom, are more precise than both the methods available to account for atmospheric effects and the current understanding of the features of sonic boom which cause annoyance and damage. Current sonic boom research of the aerospace industry includes methods to minimize sonic boom, propagation and atmospheric effects, psychoacoustic and structural response, and development of experimental techniques and facilities. B.S.D.

N68-26855*# National Aeronautics and Space Administration, Washington, D. C.
THE UNIVERSITY'S ROLE IN SONIC BOOM RESEARCH
R. Seebass *In* NAS-NRC Generation and Propagation of Sonic Boom Oct. 1967 9 p (See N68-26852 15-02)

The various areas of research on the generation and propagation of sonic booms which warrant further research are outlined and briefly discussed. These include (1) validity of the basic theory, (2) extent of the mid-field region, atmospheric effects, (4) techniques for predicting the sonic boom of hypersonic aircraft, (5) lateral spreading and multipole effects, (6) pressure distributions on various geometrical configurations, (7) far-field downward momentum flux, (8) sonic boom of exotic configurations, (9) effects of accelerations and maneuvers, and (10) engine streamtube area effects. Lists are included which give the various universities that are currently engaged in sonic boom research, the specific research objective, the investigators' approach, and the source of funds. B.S.D.

N68-26930*# Consultants in Engineering Science (CONESCO), Watertown, Mass.
PROCEDURES FOR ESTIMATING THE EFFECTS OF DESIGN AND OPERATIONAL CHARACTERISTICS OF JET AIRCRAFT ON GROUND NOISE
Robert Lee, James Farrell, George Henry, and Albert Lowe Washington NASA Jun. 1968 166 p refs
(Contract NAS1-5724)
(NASA-CR-1053) CFSTI: HC $3.00/MF $0.65 CSCL 01B

Procedures have been developed for estimating the effects of design and operational characteristics of jet aircraft on ground noise; this has been done for various engine-cycle parameters, aircraft-design characteristics, and aircraft-flight characteristics; parametric plots have been prepared to show how these different inter-related factors influence noise; and, when possible, assessments have been made of the accuracies and limitations of the graphs, nomographs, and equations that have been developed. One important general conclusion that can be drawn from all this effort is that it is feasible to develop simplified analytic procedures for relating aircraft design and flight characteristics to ground noise, and that such techniques can be extremely useful for providing design guidance and for showing how various flight paths influence ground noise. The report includes the following: Noise prediction procedures for jets and compressors. An analytical investigation of noise as a function of engine-cycle parameters for jet and fan engines. Several simplified calculational methods for determining PNdb including (a) jet and compressor noise PNdb from overall sound-pressure level, (b) PNdb of the combined jet and compressor noise from individual PNdb values, and (c) variation of PNdb with distance for jet, compressor, and jet combined with compressor noise. An analytical study of ground noise as a function of design and flight characteristics. Author

N68-26944# Sud-Aviation, Paris (France).
PROBLEMS POSED BY THE INTEGRATION OF AN AUTOMATIC FLIGHT CONTROL SYSTEM IN THE FLIGHT CONTROLS OF A HIGH SPEED AIRPLANE. APPLICATION IN THE CONCORDE SUPERSONIC AIRCRAFT [PROBLEMES POSES PAR L'INTEGRATION DU SYSTEME DE CONTROLE AUTOMATIQUE DE VOL DANS LES COMMANDES DE VOL D'UN AVION A HAUTES PERFORMANCES EXEMPLE D'APPLICATION DANS LE CADRE DU PROJET DE TRANSPORT CIVIL SUPERSONIQUE CONCORDE]

R. Deque [1966] 25 p refs In FRENCH Presented at the AGARD Conf. on Stability and Light Control, Cambridge, Engl., 20–23 Sep. 1966
CFSTI: HC $3.00/MF $0.65

Installation of an automatic flight control system is considered in light of experiences with the Concorde supersonic transport aircraft, and attention is given to both stick steering and autostabilization. Flights without the aid of automatic flight control are considered, and the automatic systems that can provide the necessary piloting aids are defined. Redundancy and automatic surveillance are discussed, and so-called double and triple autosurveillance systems are compared. The double system that was adopted was found to have a probability of loss of autostabilization on the order of 10^{-6} per hour during a three-hour flight. Integration of the system and its relation with other systems of the aircraft are also considered. Transl. by M.W.R.

N68-28951# Nord-Aviation, Paris (France).
INSTABILITY CRITERIA IN THE STUDY OF ROLL-PITCH COUPLING [CRITERE D'INSTABILITE DANS L'ETUDE DU COUPLAGE ROULIS-TANGAGE]
M. Mesniere [1966] 10 p In FRENCH Presented at the AGARD Conf. on Stability and Light Control, Cambridge, England, 20–23 Sep. 1966
CFSTI: $3.00

A simple criterion for stability in the case of rolling-pitching coupling was obtained during a study on the Griffon aircraft (Nord 1500 aircraft). Five nonlinear algebraic equations are given for the variables of normal and lateral force and the moments of rolling, pitching, and turning. Influence of steering on aircraft stabilization was considered, and a classical study was made of the problem of pitching coupling using an analogical machine. Values thus obtained were compared with theoretical results. The equations were written in the system of the principal axes of inertia. It was assumed that the weight was negligible, the speed and altitude were constant, and the incident and drag angles were small. Aerodynamic derivatives were also considered constant.
Transl. by M.W.R.

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N68-25658# Los Alamos Scientific Lab., N. Mex.
SPACE ELECTRIC POWER R AND D PROGRAM, PART 1 Quarterly Status Report, Period Ending 31 Jan. 1968
21 Feb. 1968 7 p refs
(Contract W-7405-ENG-36)
(LA-3881-MS, Pt.1) CFSTI: HC $3.00/MF $0.65

Experiments which are being conducted to determine the effect of many variables on the performance of heat pipes are described. These variables include the heat pipe design, the materials used, vapor flow conditions, vibration, type of heat pipe fluid, and the wick design and material. NSA

N68-25699*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
THIN FILM SOLAR CELL MODULE DEVELOPMENT, CADMIUM SULFIDE CELL Final Report
F. A. Blake and M. R. Stahler 1 Apr. 1968 174 p refs
(Contract NAS3-10605)
(NASA-CR-72414; DIN-68SD4233) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Two methods for the series and parallel interconnection of cadmium sulfide thin film solar cells into modules have been developed and qualified. Soldered or conductive epoxy joining processes can be used with either of two separate electrical paralleling configurations to produce modules of low joint resistivity, low weight, and high mechanical strength. Mechanical loading of the soldered electrical joint is avoided by floating it between two load bearing paths. Sample submodules of the various configurations have exceeded the requirements of specialized dynamic, tensile, and vacuum thermal cycling tests. Processes and tooling have been developed and used for the efficient fabrication of both soldered and bonded modules of 25 cells each. Author

N68-25731*# Republic Aviation Div., Fairchild Hiller Corp., Farmingdale, N. Y.
DEVELOPMENT OF A MICROINCH ACTUATOR
John M. Varga 24 Mar. 1968 64 p
(Contract NAS1-7018)
(NASA-CR-66626; FHR-3352-1; PCD-TR-68-6; PC072R0001) CFSTI: HC $3.00/MF $0.65 CSCL 09E

This report discusses the contractor's efforts to develop a stepping actuator capable of making linear displacements of 0.5 × 10^{-6} inches. The basic device consists of three sets of piezo-electric crystals, two sets of which operate as clutches and the third as an extender element. Several variations of the basic design are covered, the governing physical laws are reviewed, and the design approach is explained. The device was capable of reliable motions in the desired range with force levels of up to one pound. Author

N68-25736*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
RADIATION DAMAGE SHIELDING OF SOLAR CELLS ON A SYNCHRONOUS SPACECRAFT
Ramond C. Waddel May 1968 16 p refs
(NASA-TM-X-63232; X-710-68-195) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The ATS-I synchronous spacecraft (altitude 22,240 miles, launched Dec. 6, 1966) carried a group of conventional n-on-p, 10 ohm-cm, silicon, boron-doped solar cells with various radiation shields. The shields were, mostly, of Corning type 7940 artificial fused silica, of thicknesses from zero to 60 thousandths of an inch. The solar cell damage observed, as deduced from voltage-current curves, was larger than expected. The maximum power from cells bearing shields of 0, 1, 6, 15, 30, and 60 thousandths of an inch in thickness fell, during 416.8 days in orbit, to 11.4, 84.9, 92.5, 88.7, 86.9, and 83.5 percent of initial values, respectively. The short-circuit currents fell to 41.4, 90.1, 91.7, 92.7, 92.6, and 93.9 percent, respectively. The open-circuit voltages fell to 55.0, 97.2, 98.9, 98.7, and 98.3 percent, respectively. Author

N68-25829*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
ANALYSIS AND SELECTION OF DESIGN CONDITIONS FOR A RADIOISOTOPE BRAYTON-CYCLE SPACE POWERPLANT
John L. Klann, Leonard Soffer, Gerald J. Barna, Gabriel N. Kaykaty, Paul T. Kerwin et al Darl D. Bien Washington Jun. 1968 83 p refs
(NASA-TN-D-4600) CFSTI: $3.00/MF $0.65 CSCL 18E

Selections were made for a conceptual plutonium 238 module for electric powers in the range from 2 to 10 kilowatts. Based on the selections, component and system efficiency and weight were estimated for powers of 2, 6, and 10 kilowatts. Author

N68-25891*# Tyco Labs., Inc., Waltham, Mass.
DEVELOPMENT OF CATHODIC ELECTROCATALYSTS FOR USE IN LOW TEMPERATURE H_2/O_2 FUEL CELLS WITH AN ALKALINE ELECTROLYTE Quarterly Report, 1 Jan.–31 Mar. 1968

J. Giner, J. Parry, L. Swette, and R. Cattabroga 31 Mar. 1968 81 p
(Contract NASw-1233)
(NASA-CR-95090; Q-11, QR-11) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Longevity tests are in progress for the following O_2 cathodes: 60 Au/40 Pd, 50 Au/50 Pd, 30 Au/70 Pd, 80 Pt/20 OS, 30 Pt/70 Ag, Ni_3C and a TLI Pt black. An AB-40 electrode is also being run for comparative purposes. Tests to date range from 200 to 900 hrs duration, depending on starting sequence. Performance levels are summarized. No significant decay in activity was observed for any of the electrodes. Details of the preparation of the catalysts being tested are also given. Further work was carried out on the preparation of a finely divided Ti_3Au catalyst, and five samples of gold palladium, including a carbide and nitrocarbide were tested. Preliminary results of these studies are reported. A mathematical analysis aimed at predicting the behavior of structural variations in a PTFE bonded electrode is presented. The model assumed for the analysis is that of the flooded catalyst agglomerate. For the O_2 electrode in 30% KOH at 80°C, the computer analysis gives a realistic performance figure of 200 ma/cm^2 at 300 mv polarization and demonstrates that at a microporosity $\theta > 0.5$, catalyst utilization is not restricted by iR drop within the electrode. Furthermore, for agglomerates smaller than 1μ in diameter the Pt is completely utilized. The microporosity nevertheless does influence the total measured current density since for electrodes of constant thickness and catalyst loading the number of contributing pores increases with increasing microporosity. Author

N68-28120*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
REVIEW OF PAPERS PRESENTED AT THE 5TH ELECTROEXPLOSIVE DEVICE SEMINAR
E. E. van Landingham 1967 16 p Presented at the 9th Explosives Safety Seminar, San Diego, Calif., 15–17 Aug. 1967
(NASA-TM-X-60363) CFSTI: HC $3.00/MF $0.65 CSCL 19A

The safety requirements associated with the use of electroexplosive devices are discussed, along with the operational and functional design requirements. Summary information is presented on the development of (1) a 15-second delay squib with a completely gasless small column insulated delay and a deflagration rate of 14 seconds per foot; (2) a water arm–air safe detonator with a lightly confined column of explosive surrounded by an annular air cavity and, in turn, by a relatively heavy metal tube; (3) laser energized explosive devices which eliminate the use of all connecting metallic lines, bridgewires, spark gaps, ceramic headers, etc.; and (4) the chemical stability of flexible linear shaped charges at elevated temperatures. Tests to determine the optimum charge density show that the nitroguanidine transmission charge density should be less than 0.80 gm/cm and more than 0.35 gm/cm for reliable initiation of the base charge in air. Experimental studies on the causes of instability in shaped charges made from RDX are also reported. M.G.J.

N68-28352# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
SOLAR CELL POWER SYSTEMS FOR APL SATELLITES
Robert E. Fischell Feb. 1968 33 p
(Contract NOw-62-0604-c)
(TG-950; AD-668144)

Since 1959, the Applied Physics Laboratory has designed and launched 31 earth satellites. From very simple, low-power design in 1959, there have developed much more sophisticated solar cell power systems that generate higher power levels. This paper describes the development of various power systems and the application of several control techniques for improving satellite operating performance and reliability. Author (TAB)

N68-28786# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DIRECT COMPARISON OF VARIOUS FORMS OF ENERGY INTO ELECTRIC AND MECHANICAL POWER
G. N. Alekseyev 20 Jul. 1967 270 p refs Transl. into ENGLISH of the book "Neposredstvennoye Prevrashcheniye Razlichnykh Vidov Energii v Elektricheskuyu Mekhanicheskuyu" Moscow, Gosenergoizdat., 1963 p 1–336
(FTD-MT-64-355; AD-668263)

Contents: Direct conversion of chemical energy to electrical energy (Theory of fuel cells, Fuel cells with solid fuel, Fuel cells with gaseous fuel, Combined (solid-gas) fuel cells, Fuel cells with liquid fuel, Oxidizing reducing cells, Possibilities of application of fuel cells); Direct transformation of thermal energy into electrical and mechanical energy (Thermoelectric generators, Vacuum thermionic emission electric generators, Gas-filled thermionic emission electric generators, Plasma thermionic emission electric generators, Certain general questions for thermionic electric generators, Information on magnetohydrodynamics, Magnetohydrodynamic electric generators, Electrorocket motors); Direct transformation of nuclear energy into electrical and mechanical energy (Radioisotope electric generators, Nuclear radioisotope motors, Nuclear reactor electric generators, Nuclear reactor motors, Thermonuclear electric generators, Thermonuclear motors); Direct transformation of solar energy into electrical and mechanical energy (Solar electric generators, Solar sail, Photon rocket motor). TAB

N68-28788*# National Aeronautics and Space Administration, Washington, D. C.
PRIMARY HYDROGEN–OXYGEN FUEL CELLS FOR SPACE
Ernst M. Cohn [1967] 15 p Presented at the 29th Meeting of the AGARD Propulsion and Energetics Panel, Belgium, 12–16 Jun. 1967
(NASA-TM-X-60277) CFSTI: HC $3.00/MF $0.65 CSCL 10A

By 1975, Grove-type fuel cells may reach 70% gross thermal efficiency, with 3–5% for parasitic power. Cell-degradation rates should be 4 microvolts/hr or less, and system specific weight 60–80 lbs/kw of average load, with maintenance-free life up to 1 year. A better cathodic catalyst, optimized electrode structure, and inert matrices (if used at all) will be needed. Better solutions to chemical engineering problems are even more urgent. The best approach appears to be abandonment of the Grove cell and use of modern electrochemical knowledge in developing novel systems concepts. These may result in even greater weight and volume savings as well as simpler controls, lower parasitic power, and longer life, particularly for larger power systems. Peak-power and heat-load demands might best be met by special auxiliaries instead of overdesign of the basic equipment. In turn, pseudo-primary fuel cells may satisfy peak loads in conjunction with primary solar or nuclear systems. Author

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N68-25696# Royal Aircraft Establishment, Farnborough (England).
CUPULOMETRY
A. A. J. van Egmond and J. J. Groen Jan. 1968 20 p refs Transl. into ENGLISH from Pract. OTO-Rhino-Laryng, v. 17, 1955 p 206–223
(RAE-LIB-TRANS-1275) CFSTI: $3.00

The authors give an appraisal of the mechanical principles underlying cupulometry. It is shown that the reactions of the peripheral labyrinth can be indicated by mechanical means within physiological limits, so that one is justified in maintaining that the labyrinth actually does function mechanically. A normally healthy

person is able to influence these primary reactions of the peripheral labyrinth in the central nervous system. This influence takes the form of a reduction from the point of view of time. It is, therefore, a kind of suppression, possibly identical with an inhibition. Persons unable to exercise this central suppression exhibit a course of reactions corresponding fully with the mechanical aspects. The usefulness of cupulometry from a clinical point of view is demonstrated by reference to certain specific cases. Author

N68-25843# Atomic Energy Commission Research Establishment, Riso (Denmark).
RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN CELLS
Jakob Visfeldt Oct. 1966 188 p refs
(RISO-117) CFSTI: HC $3.00/MF $0.65

Primary objective was to determine quantitatively the relationship between chromosome aberrations and radiation dose on the basis of irradiation in vivo of human cells, and to determine the types of chromosome aberrations, if any, with which the cells were able to persist in long term cultures. Human skin was used in the first experimental series and results indicated that radiation damaged cells with abnormal chromosomes, which were capable of reproduction in cultures, carry distinct stable forms of aberrations which form part of balanced karyotypes. Experiments with short-time cultures of peripheral blood from radiation treated patients support the theory that radiation damaged lymphocytes may persist in the body for a number of years without undergoing mitotic division. Attempts to determine the quantitative dose–effect relationship after a single irradiation of human bone marrow in vivo could not be established. Experiments on newly established human leukocyte cultures irradiated in vitro indicate that at present it is not possible to employ chromosome analyses on blood cultures in human biological dosimetry. A.L.

N68-25844*# National Aeronautics and Space Administration, Washington, D. C.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES
May 1968 132 p refs
(NASA-SP-7011(50)) CFSTI: $3.00/MF $0.65 CSCL 06S

Subject coverage concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Each entry consists of a standard citation accompanied by its abstract. Author

N68-25848*# Oak Ridge National Lab., Tenn. Biology Div.
MUTAGENIC EFFECTIVENESS OF KNOWN DOSES OF GAMMA RADIATION IN COMBINATION WITH WEIGHTLESSNESS ON HABROBRACON Quarterly Progress Report, 1 Apr.–30 Jun. 1967
R. C. von Borstel May 1968 30 p refs Sponsored jointly by NASA-AEC
(NASA Order R-104)
(NASA-CR-94935; ORNL-TM-2191) CFSTI: $3.00/MF $0.65 CSCL 06R

Detailed data are given on the second-generation males in the ground based control of the Biosatellite experiment. The methods and materials for inducing recessive lethality and inherited partial sterility are described, along with the induction of mutations in Habrobracon with the antibiotic mitomycin. The different types of recessive lethal mutations are summarized, the acutal number and frequencies of inherited partial sterility effects that were found, are listed. B.S.D.

N68-25850*# Oak Ridge National Lab., Tenn. Biology Div.
NEUROSPORA EXPERIMENT P-1037 Quarterly Progress Report, 16 Mar.–30 Jun. 1967
Frederick J. de Serres and Brooke B. Webber May 1968 28 p Sponsored jointly by NASA-AEC
(NASA Order R-104)
(NASA-CR-94938; ORNL-TM-2190) CFSTI: $3.00/MF $0.65 CSCL 06M

Some of the problems encountered on the use of the passive dosimetry system for inclusion in the Neurospora modules in the Biosatellite experiments are discussed along with the development of procedures required to use these dosimeters with some assurance of accuracy. Consideration is given to the selection of thermoluminescent dosimetry system which was used to measure the gamma radiation exposures received by the conidia in the Biosatellite experiments. An investigation was conducted on the dosimeter in which the relation between dosimeter weight and sensitivity was determined. Tabulated data are given on tests conducted to determine the variability of the read-out machine, and procedures for using dosimeters varying in radiosensitivity are delineated. B.S.D.

N68-25851*# Oak Ridge National Lab., Tenn. Biology Div.
NEUROSPORA EXPERIMENT P-1037 Quarterly Progress Report, 16 Dec. 1966–15 Mar. 1967
Frederick J. de Serres and Brooke B. Webber May 1968 42 p Sponsored jointly by NASA-AEC
(NASA Order R-104)
(NASA-CR-94934; ORNL-TM-2189) CFSTI: $3.00/MF $0.65 CSCL 06M

Data from the ground control portion of the Biosatellite A experiment are presented in which the post-flight assays to determine the genetic effects of Sr^{85} gamma radiation on Neurospora are discussed. The harvesting of flask cultures of Heterokaryon is described along with the insertion of the resulting suspension into sterile modules of the Biosatellite. From the genetic analysis conducted on the neurospora, tabulated data are presented on (1) Heterodaryotic survival in conidial platings, (2) Haemocytometer count after resuspending the conidia from millipore filters, (3) jug data, which were taken from flasks inoculated with conidia from each treatment, and (4) information which contains a brief description of the mutagenic treatment. Computer print-outs are given on the results of computations performed upon each of the inoculated jugs. B.S.D.

N68-25931*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EFFECTS OF SALTS ON THE HALOPHILIC ALGA, *DUNALIELLA VIRIDIS*. 2: EFFECTS OF SALTS ON GROWTH
Mary K. Johnson, Robert D. Mac Elroy (NAS-NRC) and Emmett J. Johnson [1967] 18 p refs Prepared in cooperation with Bruce Lyon Mem. Res. Lab.
(NASA-TM-X-60278) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Consideration is given to the effects of salt on halophilic green alga, *Dunaliella viridis* and *Dunaliella salina*. Due to a discrepancy of results in previous experiments concerned with the internal salt concentration of these organisms, a detailed study was conducted on the response of whole cells of these organisms to NaCl and other salts. The materials and methods used to isolate and grow the cultures are described. Tabulated data are given on results of various experiments which include (1) effects of adding low levels of KCl to a medium containing adequate levels of NaCl, (2) the effect of dilution on cell lysis, and (3) the effect of replacing the chloride ion with other anions. B.S.D.

N68-25937*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE PHARMACOLOGICAL APPROACH TO THE STUDY OF THE MECHANISMS REGULATING ACTH SECRETION

Joan Vernikos-Danellis [1967] 15 p refs Presented at the Intern. Symp. on Pharmacol. of Hormonal Polypertides, Milan, 14–16 Sep. 1967
(NASA-TM-X-60534) CFSTI: HC$3.00/MF$0.65 CSCL 06S

Several theories are reviewed pertaining to the suggestion that catecholamines play a special role in regulating ACTH secretion due to the common association of sympathoadrenal and pituitary adrenocortical activity in stress. Details are given on experiments conducted with the α- and β-adrenergic blocking drugs. An assessment of the data indicates: (1) Catecholamines do play a role in regulating ACTH secretion, and that each member of the catecholamine group exerts distinct, varied, and often overlapping effects. (2) There is an intricate relationship and balance between the actions of circulating catecholamines exerted at pituitary and hypothalamic level and those exerted by centrally located amines on the various structures of the central nervous system. The suggestion is made that, in addition to the negative feedback loop between adrenal cortex and central CRF controlling centers, a positive feedback loop may exist between adrenal cortex and anterior pituitary mediated by epinephrine from the adrenal medulla.
M.G.J.

N68-25944*# Stanford Univ., Calif. Dept. of Biochemistry.
STUDIES OF THE CONFORMATION OF PYRIDINE NUCLEOTIDE COENZYMES. 1: ORD SPECTRA AND HYPOCHROMICITY OF NADH
Peter M. Bayley [1967] 56 p refs
(Grant NGR-05-020-137)
(NASA-CR-94931) CFSTI: HC$3.00/MF$0.65 CSCL 06A

The ORD, absorption and fluorescence spectra of NADH and its components have been examined to see if NADH shows the properties of a stacked system. The ORD spectrum of NADH is not the sum of the contributions of AMP and NMNH. The rotatory contribution resulting from intramolecular interaction between adenine and 1,4 dihydronicotinamide moieties is eliminated by pyrophosphatase digestion, heating or addition of certain organic solvents. The interactions giving rise to the ORD spectrum of NADH are complex. The system is non-conservative, indicating interaction of the 340 mμ dihydronicotinamide and the 260 mμ adenine transitions with unidentified higher energy transitions. These optical properties render unlikely a conformation in which the two bases are coplanar. The measurement of hypochromicity of NADH by digestion with pyrophosphatase at 37° has been shown to be subject to errors due to the subsequent reaction of NMNH with water. Digestion at 22° is free from this artefact. It is found that both the 260 and 340 mμ bands are hypochromic relative to the separate chromophores, AMP and NMNH.
Author

N68-25974*# Fort Detrick, Frederick, Md. Protection Branch.
SURVIVAL OF MICROORGANISMS ON COVERED STAINLESS STEEL INITIALLY CONTAMINATED BY HANDLING AND BY AERIAL FALLOUT DURING A 2 1/2 YEAR STUDY
Dorothy M. Portner 3 Jun. 1968 7 p refs *Its* Test No. 13–68
(NASA Order R-35)
(NASA-CR-94923) CFSTI: HC$3.00/MF$0.65 CSCL 06M

As part of the overall investigation of spacecraft sterilization, this study was undertaken to determine the death rate of naturally accumulated microorganisms on stainless steel strips. One half of the sterile strips were contaminated by exposure to aerial fallout for 22 days, and the other one half by handling by 5 people. Following contamination the strips were stored for periods of from 2 weeks to 2 1/2 years before being assayed. Tables listing the number of microorganisms recovered from contaminated plates are given for each storage period. Results indicate that the die-off of naturally accumulated microorganisms on surfaces is insufficient to produce a sterile spacecraft in a reasonable time by merely covering the constructed craft with a shroud and allowing it to stand. The study also showed that there is an initial rapid death rate of microorganisms on surfaces contaminated by aerial fallout or handling, which was followed by a very slow death rate of the remaining few. The latter rate was so slow it was not obvious over a one year period but was in 2 1/2 years.
A.L.

N68-26028# Technische Hochschule Munchen (West Germany).
CONTRIBUTIONS TO PEPTIDE SYNTHESIS [BEITRAEGE ZUR PEPTIDSYNTHESE]
Peter Huber (Ph.D. Thesis) 1967 80 p refs In GERMAN
CFSTI: HC$3.00/$0.65

Anhydrides and 1-hydroxy-piperidine-hydrochloride were used to form amino acid-1-hydroxy-piperidylesters which were changeable into N-acyl-dipeptide-1-hydroxy-piperidylesters through various peptide links. Subsequent reactions with amino acidester-hydrochlorides and Na-acetate gave good yields of N-acyl-tripeptide-ester. The reactions of N-acyl-amino acids with p-bromine-phenacylbromide and triethylamine produced several Z-amino acid-p-bromide-phenacylesters. Reaction of methyl-ethinyl-diathylamine with H-L-Phe-benzylester was used to synthesize the nonapeptide derivative all-L-Leu-Ile-Ile-Leu-Val-Pro-Pro-Phe-OBz1.
Transl. by G.G.

N68-26131*# School of Aerospace Medicine, Brooks AFB, Tex.
STATUS OF RESEARCH TO DETERMINE RADIOBIOLOGICAL RESPONSE CRITERIA FOR SPACE MISSIONS
Edwin R. Ballinger *In* NASA, Washington Protect. Against Space Radiation 1968 p 33–42 ref (See N68-26128 15-29)

A general review is presented of the status of research designed to determine radiobiological response criteria for space missions; and a comparison is made of (1) clinical/research and space radiations and (2) electron and proton penetrations in man and in primate. The radiation problem in space appears to be concerned with the Van Allen belt, the regions of electromagnetic pathways of solar flares, the near-earth regions of trapped artificially injected electrons from man-made nuclear explosions, and possibly the radiations electromagnetically trapped in the fields of other stars or planets. Earlier criteria based on high energy penetrating radiation given at high dose rates or over a portion of the body may require modification.
M.W.R.

N68-26172*# Aztec School of Languages, Inc., Acton, Mass.
THE EFFECTS OF RADIANT HEAT ON VARIOUS REGIONS OF THE HUMAN BODY [SUGLI EFFETTI DEL CALORE RADIANTE SU REGIONI DIVERSE DEL CORPO UMANO]
V. Wyss Washington NASA May 1968 12 p refs Transl. into ENGLISH from Med. Lanoro (Italy), v. 56, no. 4, 1965 p 293–303
(Contract NASw-1692)
(NASA-CR-94963) CFSTI: $3.00 CSCL 06P

In considering the effects of radiant heat on man, the author has investigated the time sequence in which perspiration appears on the face and on equal surface areas of the thorax and abdomen, in subjects acclimated and unacclimated to locally applied infrared heat. The subjects exposed the chosen surface to the heat through a window of adjustable dimensions, in a shield cooled by circulating water; this shield protected the rest of the body from the heat. In unacclimated subjects, perspiration began to appear after an exposure of 180 sec, first on the abdomen and thorax and then on the face; the skin temperature was lower on the face than in the other two regions. The topographical order of appearance of perspiration, the lack of dependence of skin temperature on the appearance of perspiration, and the differences of times of perspiration are discussed.
Author

N68-26207*# National Aeronautics and Space Administration, Washington, D. C.
BIOREGENERATIVE SYSTEMS
1968 152 p refs Proc. of a Conf. held in Washington, D. C., 15–16 Nov. 1966
(NASA-SP-165) GPO: HC$1.50; CFSTI: MF$0.65 CSCL 06M

Topics presented at this conference cover the application of Hydrogenomonas–chemosynthesis and algae-photosynthesis

processes in future bioregenerative life support systems for long duration space travel. Advantages and disadvantages of both systems are outlined and the possibility of a combined chemosynthetic-photosynthetic system is considered. G.G.

N68-26209*# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.

CHEMOSYNTHETIC METABOLISM OF HYDROGENOMONAS

Leonard Bongers and John C. Medici *In* NASA. Washington Bioregenerative Systems 1968 p 9–18 refs (See N68-26207 15-04)

The chemosynthetic metabolism of *Hydrogenomonas eutropha* is analyzed with emphasis on the physiological requirements for batch and continuous cultures, product composition, and turn-over characteristics. Rapid growth of the *H. eutropha* can be obtained by a medium containing urea or an ammonia-nitrogen source in the presence of magnesium, phosphate, and ferrous iron. Carbon dioxide and oxygen concentrations are critical in the gaseous substrates that provide the suspensions with energy and carbon dioxide; the latter proved harmful in concentrations above 9 cm and the oxygen partial pressure had a strong effect on growth rate, energy conversion efficiency, and metabolic activity. Conversion efficiency in the presence of terminal oxidase inhibitors decreased and retarded the growth rate. The rate of culture growth in suspension under steady state conditions at maintained gas concentrations of 12 percent oxygen, approximately 9 percent CO_2 and H_2 as balance yielded test data that gave at extrapolation a suspension-volume requirement of about 20 to 30 liters per astronaut for a working suspension density of about 5 grams dry weight per liter. G.G.

N68-26210*# Washington State Univ., Pullman.

BIOCHEMISTRY AND PHYSIOLOGY OF HYDROGEN BACTERIA: BIOCHEMICAL DIFFERENCES IN HETEROTROPHS AND AUTOTROPHS

Bruce A. Mc Fadden *In* NASA. Washington Bioregenerative Systems 1968 p 19–28 refs (See N68-26207 15-04)
(Grant NGR-48-001-004)

The carbon metabolism of Hydrogenomonas facilis was studied in an effort to define the differences between hetero- and autotrophic modes of growths because a mutation of hydrogen bacteria to obligate heterotrophism during space flight would be lethal to the passengers in a closed bioregenerative system. Labeling patterns and specific enzyme assays detected TCA cycle intermediates arising from $^{14}CO_2$ fixation during ribose oxidation. After the establishment of apparently optimal conditions for the assay of ATP-, NADH- dependent $^{14}CO_2$ fixation, RuDP carboxylase and Ru5–P kinase, the specific activities for these processes were determined in regions of first order dependence upon protein concentration. The kinase activity did not parallel $^{14}CO_2$ fixation as closely as that of RuDP carboxylase. A significant fraction of the $^{14}CO_2$ fixed during ribose oxydation by H.facilis was assimilated via the Calvin cycle. It was concluded that levels of carboxylase and hydrogenase are catalyst that may regulate this flux and that these are suppressed by heterotrophic growth. G.G.

N68-26211*# National Institutes of Health, Bethesda, Md.

ENZYME SYSTEMS AND ELECTRON TRANSPORT

Roy Repaske *In* NASA. Washington Bioregenerative Systems 1968 p 29–33 (See N68-26207 15-04)

Enzyme systems and electron transport reactions were studied in cell-free extracts of autotrophically grown Hydrogenomonas eutropha with emphasis on hydrogenase coupled to pyridine nucleotide reduction. Of a complete series of ribose tri-, di-, and mono-nucleotides tested, only ATP and ADP gave significant stimulation. Heterotrophically grown cells had the same cytochrome complement as autotrophically grown cells, but hydrogenase activity measured by methylene-blue or DPN reduction was less than one fiftieth of that found in autotrophically grown cells. DPNH menadione ferricyanase reductase from both types of cells was the same. Preliminary findings indicates that heterotrophic growth affects the amount of hydrogenase present in the cells. G.G.

N68-26212*# Mississippi State Univ., State College.

METABOLIC PRODUCTS OF HYDROGENOMONAS EUTROPHA

Robert G. Tischer and Lewis R. Brown *In* NASA. Washington Bioregenerative Systems 1968 p 35–38 refs (See N68-26207 15-04)

Work on the identification and quantification of extracellular products used and produced by H. eutropha during autotrophic growth centered on comparisons between fructose grown cells and autotrophically grown cells. It was found that H. eutropha metabolized fructose wholly or partly with autotrophically grown cells exhibiting an RQ value of about 0.4 after 90 minutes, while fructose grown cells established an RQ of 0.9 or almost the theoretical 1.0 in the same time; apparently the use of hydrogen was not inhibited. Glucose solutions autoclaved at pH's 6.0 to 10.0 increased oxygen consumption of resting cells markedly thus indicating higher fructose production by possible breakdown and mutation. Since glucose is suitable for human consumption, steps should be taken to increase the production of glucose by H. eutropha and at the same time reduce the production of pentoses ribose, xylose, and arabinose. G.G.

N68-26213*# Catholic Univ. of America, Washington, D. C.

GENETIC STABILITY OF HYDROGENOMONAS EUTROPHA

Benedict T. De Cicco *In* NASA. Washington Bioregenerative Systems 1968 p 39–48 refs (See N68-26207 15-04)

Hydrogen oxidation was observed for a presumably normal H. eutropha culture during cultivation as a function of culture age and autotropic conditions in urea. Cultures were incubated under air to allow the cells to undergo one and a half to two divisions and were then assayed for hydrogenase activity. Data showed that the activity was not suppressed but rather increased under heterotropic conditions to the maximum autotropic level. It was concluded that H. eutropha contains a constitutive type of hydrogenase. Comparative growth studies with glutamate solution using both autotrophic and heterotrophic mechanisms simultaneously showed some temporary inhibition because of glutamate exhaustion until induction of the catabolic system took place. Some nutritional mutants of E. eutropha were isolated and identified in a search for E. eutropha phages in soil, water, and sewage sources. Effects of phage infection during autotrophic and heterotrophic growth were not yet conclusive. G.G.

N68-26214*# California Univ., Berkeley.

NUTRITIONAL PROPERTIES OF HARVESTED HYDROGENOMONAS EUTROPHA

Doris H. Calloway *In* NASA. Washington Bioregenerative Systems 1968 p 49–54 refs (See N68-26207 15-04)

Biological quality and lipid digestibility of H. eutropha cells were studied for the inherent food value during manned space flight. It was found that a man requires a daily consumption of about 700–800 g of bacterial solids daily to obtain 90 to 100g of nitrogen and 50–60g of nucleic acids. This would require excretion of 4–5 liters of urine and if purine and pyramidine based are absorbed, the large quantities converted to uric acid constitute a serious problem. A substantial risk of forming urate stones in the renal system or development of gout is envisioned. The author concludes that high protein organisms cannot serve as sole dietary energy source. G.G.

N68-26215*# TRW Systems, Redondo Beach, Calif.

GROWTH OF HYDROGENOMONAS EUTROPHA IN URINE FOR APPLICATION TO A BIOREGENERATIVE LIFE-SUPPORT SYSTEM

Bernard H. Goldner and J. B. Dittman *In* NASA, Washington Bioregenerative Systems 1968 p 55–66 refs (See N68-26207 15-04)

In closed ecological systems proposed for extended manned missions, it will be necessary to regenerate food from human wastes, such as CO_2, urine, and feces. In addition, a suitable atmospheric balance between C_2 and CO_2 must be maintained. A bioregenerative life-support system that offers the advantages of producing food material from wastes, as well as providing an atmospheric balance, is being developed and consists of combining the electrolysis of water with the autotrophic growth of *H. eutopha*.* Urine can serve as a major source of nutrients for *H. eutropha* since it contains urea as a nitrogen source and all the inorganic salts required in the autotrophic nutrition of this bacteria. This paper describes an investigation of the nutrition, physiology, and culture characteristics of *H. eutropha* grown in urine, with the result that a material balance is feasible between the volume of urine excreted, the amount of CO_2 produced by human respiration, and the volume of CO_2 utilized by a culture of *H. eutropha*. Author

N68-26216*# Battelle Memorial Inst., Columbus, Ohio.
CURRENT PROBLEMS IN THE CULTIVATION OF HYDROGENOMONAS BACTERIA UNDER CONTROLLED ENVIRONMENTS IN THE TURBIDOSTAT
John F. Foster and John H. Litchfield *In* NASA, Washington Bioregenerative Systems 1968 p 67–74 refs (See N68-26207 15-04)

Experimental results with a continuous culture of H. eutropha maintained within controllable variables in a turbidostat found a spontaneous growth decrease as cell density increased. The effects of environmental variables on assimilation of urea and gases, growth rate, and cell composition are analyzed and it is shown that the urea transforms into an intermediate product before its conversion into cellular matter; this intermediate product causes the growth rate to peak. It is assumed that a feedback control mechanism in the later development stages of the culture induces much more rapid conversion of urea with decomposition and ammonia production. G.G.

N68-26217*# Minnesota Univ., Minneapolis.
ANALYSIS OF CONTINUOUS MICROBIAL PROPAGATION
A. G. Fredrickson and Henry M. Tsuchiya *In* NASA, Washington Bioregenerative Systems 1968 p 75–84 refs (See N68-26207 15-04)

This formulation of general models for continuous microbial propagation extrapolates individual cell behavior to cell-population behavior by encorporating quantitative terms from the gas phase, the liquid phase, and the biological phase. Mathematical equations are deduced from the principle of conservation of mass of chemical species, the principles of stoichiometry as applied to biochemical reactions in the biological phase, and the principles governing interfacial mass transfer. G.G.

N68-26218*# Minnesota Univ., Minneapolis.
THE FOOD CHAIN
J. F. Drake, J. L. Jost, A. G. Fredrickson, and Henry M. Tsuchiya *In* NASA, Washington Bioregenerative Systems 1968 p 87–95 refs (See N68-26207 15-04)

A set of modified Lotka-Volterra equations, representing the relationship between population densities in a food chain, were applied to continuous as well as batch cases for a system of D. discoideum and Escherichia coli in which populations of the two were grown in simple glucose, ammonium-sulfate, salts medium. Equations were developed to establish the interactions between the D. discoideum, the E. coli, and glucose where the population density of the D. discoideum depends primarily on the availability of E. coli., and where the density of E. coli depends on the limiting supply of glucose and on the predation by D. discoideum. The various constants were determined experimentally in batch cultures and then incorporated into the model by computer. With the constants used, the model predicted bacterial maxima of 14×10^8 per ml as compared with 13×10^8 per ml found experimentally. For batch cultures, the model predicted the general trends that were observed experimentally, except that it predicted no lag for the bacteria. G.G.

N68-26219*# Maryland Univ., College Park.
THE PHYSIOLOGY AND BIOCHEMISTRY OF ALGAE, WITH SPECIAL REFERENCE TO CONTINUOUS-CULTURE TECHNIQUES FOR CHLORELLA
Robert W. Krauss *In* NASA, Washington Bioregenerative Systems 1968 p 97–109 refs (See N68-26207 15-04)

Those aspects of algal physiology are studied that are pertinent to the employment of Chlorella in continuous culture devices and life support system prototypes for manned space travel. Extrapolated optimal performance characteristics of Chlorella for long-term cell production of not more than 1 gram per liter per day showed that a volume of 436 liters per man is required to supply the necessary human oxygen. Considerable gains in culture volume efficiency can be obtained by increasing the amount of surface illuminated per unit volume of algae. Laboratory experiments with an automatic cycling recyclostat that keeps the algal culture at a preset population density level by filtration and culture restitution gave good results. G.G.

N68-26220*# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.
THE RATE-LIMITING REACTION IN PHOTOSYNTHESIS
Bessel Kok *In* NASA, Washington Bioregenerative Systems 1968 p 111–115 refs (See N68-26207 15-04)

Beyond a certain intensity, photosynthesis does not accelerate with increasing light since temperature dependent enzymic processing steps in algae or Hydrogenomonad cultures keep only pace with a limited quanta flux into the photochemical conversion centers. The locus of the rate-limiting dark step in the electron transport sequence was determined. Flash experiments established the rate of CO^2 concentration as one of the limiting steps if all other supplies were abundant. Delay measurements on the electron reaction chain between two photoacts seemed to indicate the electron transfer between the two enzymes, cytochrome and plastocyanin, as the limiting reaction. G.G.

N68-26221*# School of Aerospace Medicine, Brooks AFB, Tex.
ECOLOGIC RELATIONSHIPS BETWEEN BACTERIA AND ALGAE IN MASS CULTURE
C. H. Ward (Rice Univ.) and J. E. Moyer (Robert S. Kerr Water Res. Center, Ada, Okla.) *In* NASA, Washington Bioregenerative Systems 1968 p 117–127 refs (See N68-26207 15-04) (NASA Order R-99)

Algal-bacterial interactions were examined in order to elucidate the effects of contaminant bacteria on mass cultures of algae used for photosynthetic gas exchange. Isolation experiments with Chlorella sorokiniana cultures, illuminated by fluorescent lamps and aerated with carbon dioxide enriched air, revealed a variety of heterotropic bacterial forms. Soil and air bacteria did not survive well when inoculated into axenic algal cultures but human pathogens exhibited unexpected growth. Organic acid assays of algal excretory products indicated that the bacteria utilized much more amino acids than organic acids; it is assumed that this explains the tendency of algal cultures to support only a few types of bacteria to eliminate the products excreted during algal growth. G.G.

N68-26222*# Georgia Univ., Athens.
THE CASE FOR THE MULTISPECIES ECOLOGICAL SYSTEM, WITH SPECIAL REFERENCE TO SUCCESSION AND STABILITY
G. Dennis Cooke, Robert J. Beyers, and Eugene P. Odum *In* NASA, Washington Bioregenerative Systems 1968 p 129–139 refs (See N68-26207 15-04)

Properties and components of multi-species bioregenerative systems for long space flight support are discussed with emphasis on succession and stability. An ecological succession model is used to compare a mature ecosystem and a young two-species system for their ratios of grass and total photosynthesis in relation to biomass and against time while undergoing autothropic succession. The interdependency of the microecosystem components is demonstrated by the high diversity and high stability in mature systems, and the low diversity and stability in the early stages. Calculations established the necessary area to support an astronaut as about 2 acres of multispecies biomass. G.G.

N68-26262# Joint Publications Research Service, Washington, D. C.

CYBERNETIC APPLICATIONS IN BIOLOGY AND MEDICINE

A. I. Berg 10 Jun. 1968 109 p refs Transl. into ENGLISH from Kibernetiku na Sluzhbu Kommunizmu (Moscow), v. 4, 1967 p 5-9, 217-290
(JPRS-45606)

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1. CONTROL PROCESSES IN THE ORGANISM OF MAN UNDER BURN SHOCK Ye. V. Gubler, A. A. Pervozvanskiy, and I. B. Chelpanov p 7-23 refs (See N68-26263 15-04)

2. DEFINING THE CONCEPTS OF HEALTH AND DISEASE IN CONNECTION WITH SOLVING AUTOMATIC DIAGNOSTIC PROBLEMS V. S. Genes p 24-33 refs (See N68-26264 15-04)

3. QUALITATIVE EVALUATIONS OF RECOGNITION SYSTEMS BASED ON THE METHOD OF COMPARISON WITH RESPECT TO A SET OF ATTRIBUTES AS A WHOLE V. S. Genes p 34-45 refs (See N68-26265 15-04)

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6. PRINCIPLES OF CONSTRUCTION OF DIAGNOSTIC SYSTEMS WITH THE HELP OF MATHEMATICAL MACHINES M. L. Bykhovskiy and A. A. Vishnevskiy p 77-95 refs (See N68-26268 15-04)

7. REGULATION OF THE ASCENDING FLOW OF INFORMATION BY THE CORTICOFUGAL FEEDBACK SYSTEM R. M. Meshcherskiy p 96-107 refs (See N68-26269 15-04)

N68-26263# Joint Publications Research Service, Washington, D. C.

CONTROL PROCESSES IN THE ORGANISM OF MAN UNDER BURN SHOCK

Ye. V. Gubler, A. A. Pervozvanskiy, and I. B. Chelpanov *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 7-23 refs (See N68-26262 15-04)

General reactions of the organism during the first few days following a severe burn are considered in the context of an automatic control process, with reversible burn shock viewed as a transient process. A pathophysiological diagram is constructed based on the premise that the regulation process in the organism is aimed at keeping all the basic physiological parameters within certain limits. For mathematical simulation, a simpler structural diagram is developed to reflect the basic relationships in the control process during burn shock in general form. A series of blocks is used to depict the transformation of the composition and properties of blood flowing through the organisms, and the regulating relationships having a parametric effect on the conversion properties of the blocks. Physiologically, these are nervous or humoral relationships. Consideration is also given to the phase space of characteristic variables defining the operating condition of the organism. M.G.J.

N68-26264# Joint Publications Research Service, Washington, D. C.

DEFINING THE CONCEPTS OF HEALTH AND DISEASE IN CONNECTION WITH SOLVING AUTOMATIC DIAGNOSTIC PROBLEMS

V. S. Genes *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 24-33 refs (See N68-26262 15-04)

The problems of defining the qualitative differences of normal and pathological states are discussed in relation to the application of cybernetic methods for diagnosing various states and diseases. The question of who is to be considered a healthy individual is examined in an attempt to formulate the indices for defining the concept of health, and to determine the conditions under which the functions of the organism should be investigated. A synthetic formula is given which lists the features to be assessed when developing diagnostic systems for disease. Based on these concepts, three groups of indices are proposed: (1) morphological and functional indices of the vital activity of the organism; (2) functional preparedness for certain social conditions; and (3) the effect of the given organism on other organisms (behavior, generation of pathogenic microbes, etc.) Also considered important are the observation of homeostasis, the degree of stress of the regulatory systems maintaining homeostasis, the possibility of participation in social production, and the attitude of the subject toward his environment. M.G.J.

N68-26265# Joint Publications Research Service, Washington, D. C.

QUALITATIVE EVALUATIONS OF RECOGNITION SYSTEMS BASED ON THE METHOD OF COMPARISON WITH RESPECT TO A SET OF ATTRIBUTES AS A WHOLE

V. S. Genes *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 34-45 refs (See N68-26262 15-04)

The question of what is to be taken as the basis for evaluating the attributes and systems of attributes from the viewpoint of their validity for recognizing phenomena, states, and diseases is considered. It is pointed out that the most complete evaluation of a recognition system of this type is based on a method of determining the proportion of correct diagnoses when testing a new group of cases of phenomena or diseases. Several examples are given. Also discussed is the problem of evaluating the diagnostic system while collecting observed data on each of its levels. Procedures for evaluating individual attributes are listed as the degree of connection of a certain state of a symptom with a given disease, and the degree of specificity of the given state of the symptom for the given disease in a system of diseases which are differentiable from each other. M.G.J.

N68-26266# Joint Publications Research Service, Washington, D. C.

CYBERNETIC TECHNIQUES IN MEDICINE

N. M. Amosov *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 46-59 (See N68-26262 15-04)

The general problems of the structure and functioning of living systems are discussed, and diagrams of the regulating system (RS) of the organism are introduced. The first RS represents the internal environment of the organism (blood and lymph together with the operating internal organs) maintaining its composition. The second RS is the endocrine system, consisting of several levels and divisions. The third RS is the vegetative nervous system which is conditionally divided with respect to the spinal cord and medulla oblongata, the subcortex with the reticular formation, and the cortex. The direct and inverse effects of the RS on each other and on the operating organs are examined. The difficulties involved in actually simulating disease programs are assessed, and two types of programs are proposed: (1) an active model in which the parameters and the point of application of the pathological stimulus are given, and in which the characteristics of the organs of a patient are individual and correspond to his sex, age, and constitution; and

(2) tables in which degrees of damage to various organs are presented with respect to the levels of development of the disease. M.G.J.

N68-26267# Joint Publications Research Service, Washington, D. C.
SOME PROBLEMS IN THE SIMULATION OF COMPLEX SYSTEMS
N. M. Amosov *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 60–76 (See N68-26262 15-04)

A program for complex systems is defined as the possibility of variation of a system in space and time inherent in the structure of the system itself and realized under certain external effects. The necessity for simultaneously developing systems and programs is discussed, and several general principles of systems development are stated. The variations in human programs and their external expressions in information are considered, and simulation techniques are described in terms of the growing capabilities of computers for processing and encoding information. M.G.J.

N68-26268# Joint Publications Research Service, Washington, D. C.
PRINCIPLES OF CONSTRUCTION OF DIAGNOSTIC SYSTEMS WITH THE HELP OF MATHEMATICAL MACHINES
M. L. Bykhovskiy and A. A. Vishnevskiy *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 77–95 refs (See N68-26262 15-04)

The application of modern mathematical methods and computer equipment to the problem of processing medical information is discussed. The cybernetic diagnostic process is considered as a dynamic procedure consisting of alternating steps of examining the patient, evaluating the data obtained from one series of tests, and prescribing the next group of tests. Deterministic logic is used to select the diseases for the given symptoms from the total class of diseases. Algorithms for determining the phase representations in the problems of pathology and diagnostics are presented. Probability logic is used to evaluate the possibility of various diseases for the given clinical picture. A phase interval technique, which may be used to describe the normal or pathological state of the organism, is described. An example is given of a diagnostic system which correctly diagnosed over 90% of 200 congenital heart defect cases. M.G.J.

N68-26269# Joint Publications Research Service, Washington, D. C.
REGULATION OF THE ASCENDING FLOW OF INFORMATION BY THE CORTICOFUGAL FEEDBACK SYSTEM
R. M. Meshcherskiy *In its* Cybernetic Appl. in Biol. and Med. 10 Jun. 1968 p 96–107 refs (See N68-26262 15-04)

Various opinions are assessed on the existence and functional significance of the corticofugal feedback from the projection zones of the feedback to the specific relay nuclei of the thalamus. Experimental data are presented on the interrelationships between the relay thalamic nucleus (the lateral geniculate body) and the projection optic region of the cortex characterized by two-way communications. Based on the results obtained, the theory of the stochastic structure of the nervous system with passage of all pulses through the network on the probability principle is questioned. M.G.J.

N68-26293*# Minnesota Univ., Minneapolis. Space Science Center.
ENVIRONMENTAL MICROBIOLOGY AS RELATED TO PLANETARY QUARANTINE. Progress Report
Richard Swalin et al Dec. 1967 29 p refs
(Grant NGR-24-005-063)
(NASA-CR-94806) CFSTI: $3.00/MF $0.65 CSCL 06M

Summary data are presented on several research projects pertaining to spacecraft sterilization and interplanetary quarantine. These include: studies on (1) optimizing space hardware assay methodology in order to determine specifically the procedures for greater recovery of viable contaminants under a variety of conditions; (2) the effect of storage conditions on the die-off of organisms over given time periods; (3) the effects of surface sterilization treatments on occluded contaminants in polymerizable plastics; (4) the evaluation of sampling equipment and levels of microbial contamination in different types of air systems; (5) the chemical properties of nucleotides on thin-layer chromatographic planes; and (6) the properties of mated surfaces affecting the heat destruction of microorganisms. M.G.J.

N68-26332# Keio Univ., Tokyo (Japan). Dept. of Physiology.
MECHANISMS SUBSERVING COLOR CODING IN THE VERTEBRATE RETINA. Final Report, Oct. 1966–Jan. 1968
Tsuneo Tomita APO San Francisco Army Res. and Devel. Group Far East Mar. 1968 40 p refs
(Grant DA-CRD-AG-S92-544-67-657)
(J-228-6; AD-667977)

The responses used as indices of studying color reception are potential changes with latencies of several msec recorded from within single photoreceptors using micropipette electrodes having tip diameters less than 0.1 micron. Single carp cones are used for the study, but single octopus photoreceptors are also used to provide matrials for discussion of the significance of the receptor potential upon the flow of information within the receptor. The intracellular placement of the electrode is achieved by mounting the retina on a vibrating table which gives it a large acceleration against the slowly advancing electrode tip. The electrode penetration is signalled by the appearance of a resting potential of 30 - 40 mV. In single carp cones, responses to light are hyperpolarizing. The response spectra studied statistically are classified into three groups in terms of wavelengths of maximum sensitivity. These are in close agreement with those of the absorption spectra of single goldfish cones reported by Marks and MacNichol. The response of single octopus photoreceptors, studied as a control, is a graded sustained depolarization, as common in most invertebrate photoreceptors. The action spectrum calculated therefrom agrees well with the absorption spectrum of the receptor photopigment. Evidence is provided that each octopus photoreceptor is selectively sensitive to a certain plane of polarized light. Author (TAB)

N68-26364# Ohio State Univ. Research Foundation, Columbus
VISUAL PERFORMANCE FOLLOWING HIGH INTENSITY FLASHES. Final Report, 16 May 1966–15 May 1967
Norma D. Miller, Vincent M. King, and John Schoessler Jan. 1968 97 p refs
(Contract AF 41(609)-3078)
(AD-668131)

Three separate investigations into various areas of visual function at high levels of adaptation are reported. The reciprocity relationship between duration and intensity was studied for flashes of the order of 10 to the 7th power td.sec and for durations of 1.2 msec and 1.5 sec. There was approximately a 40% increase in recovery times for Sloan-Snellen test letters following the longer flashes. The effect of varying the interval between two 250 millimicron sec flashes on the subsequent recovery times was investigated. The interval between flashes was varied from zero to 1 msec in 100 microsec increments. The total integrated luminous energy in the flashes was of the order of 10 to the 7th power td.sec. There was a statistically significant change in recovery time with the interval between flashes at the 5% level. The 700 microsec interval resulted in an 18% increase in recovery compared with the zero interval for 630 mL targets. This is equivalent to more than doubling the energy in the zero interval or 500 microsec duration case. In the third portion of the work, increment thresholds were measurad for 45 monochromatic flashes superimposed on a 10 degree white light background of various illuminance levels from 10 td to 50,000 td. At the higher levels, marked notches appear in the sensitivity function at 570 millimicrons and 470 millimicrons as previously reported by Sperling.

Analysis of the results show a striking similarity with the purity threshold curve and with MacAdams ellipse for the white point of the chromaticity diagram. Author (TAB)

N68-26500# Advisory Group for Aerospace Research and Development, Paris (France).
PRINCIPLES OF BIODYNAMICS AS APPLIED TO MANNED AEROSPACE FLIGHT. SECTION A: PROLONGED ACCELERATION: LINEAR AND RADIAL
[1968] 90 p refs CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ACCELERATION TERMINOLOGY: TABLE OF COMPARATIVE EQUIVALENTS 6 p refs (See N68-26501 15-05)
2. AN INTRODUCTION TO THE PHYSICS AND PHYSIOLOGY OF ACCELERATION 23 p (See N68-26502 15-04)
3. THE DYNAMICS OF ROTATION APPLIED TO CENTRIFUGES 14 p (See N68-26503 15-05)
4. A SUMMARY OF HUMAN TOLERANCE TO PROLONGED ACCELERATION 35 p refs (See N68-26504 15-04)

N68-26502# Advisory Group for Aerospace Research and Development, Paris (France).
AN INTRODUCTION TO THE PHYSICS AND PHYSIOLOGY OF ACCELERATION
In its Principles of Biodyn. as Appl. to Manned Aerospace Flight. Sect. A [1968] 23 p (See N68-26500 15-04)

The stress problems resulting from the tremendous forces imposed on human beings flying in modern day sonic and supersonic aircraft are considered. The history of acceleration and its relation to aviation medicine are briefly reviewed, as well as the conventional terminology used for discussing these forces and their effects. The basic essentials of motion and the types of acceleration in relation to the motion of aircraft are outlined. Factors that help to determine the physiological effects of accelerative forces on man, methods of protection against the effects of acceleration, escape problems related to development of high performance aircraft, and the problems of tumbling following emergency escape from aircraft are discussed. A.L.

N68-26504# Advisory Group for Aerospace Research and Development, Paris (France).
A SUMMARY OF HUMAN TOLERANCE TO PROLONGED ACCELERATION
In its Principles of Biodyn. as Appl. to Manned Aerospace Flight. Sect. A [1968] 35 p refs (See N68-26500 15-04)

Based on a literature survey, tabular and graphical data are presented on the stimulus-response relationships existing between man's tolerance and the duration of sustained acceleration. Standard terminology is used. Most of the graphs present the magnitude of acceleration on an arithmetic ordinate axis and the duration of exposure on a logarithmic abscissa. Separate groups of graphs are included for each direction of acceleration. For each graphic summary of magnitude, direction, and duration, a stick figure illustration of the subject's attitude is given (with respect to the acceleration vector) and a table provided which defines each point on each graph with respect to selected variables. Also discussed is the important, but obscure, relationship that exists between the anatomic footward inertia component of any acceleration ($+G_z$) and the physiologic $+G_z$ (retinal-aortic $+G_z$) axes in causing blackouts or loss of consciousness due to acceleration. The criteria used in establishing tolerances are also defined. A.L.

N68-26531# Applied Physics Lab., John Hopkins Univ., Silver Spring, Md.
ELECTROGRAPHIC DATA ON THE OPERATION OF "BIOLOGICAL CLOCKS" OF THE HUMAN BRAIN
L. G. Voronin and V. F. Konovalov 30 Jan. 1968 18 p refs Transl. into ENGLISH from Vopr. Psikhologii (Moscow), no. 6, 1966 p 87-94
(Contract NOw-62-0604-c)
TG-230-T542: AD-668013)

Some electrographic indices (EEG, GSR and OR) that are manifested as a time reflex in trace conditioning were investigated using a polygraph recording procedure. The experimental schedule was as follows: a sound stimulus (the conditioning stimulus) was coupled with a light stimulus (the reinforcement). The interval between these stimuli was 60 seconds. The dynamics of electrographic reactions in the process of forming the link between the coupled stimuli is described. The possible mechanisms involved in marking-off time by the human brain are discussed. Author (TAB)

N68-26562*# Miami Univ., Fla. Inst. of Marine Science.
THERMAL ANOMALIES IN MEMBRANE PROPERTIES
Anitra Thorhaug and W. Drost-Hansen [1968] 8 p refs Presented at 2d Intern. Biophys. Congr., Vienna, Sept. 1966 Sponsored in part by NSF and Natl. Acad. of Sci. *Its* Sci. Contrib. No. 000
(Grant NGR-10-007-010)
(NASA-CR-87776) CFSTI: HC $3.00/MF $0.65 CSCL 06C

The anomalies within water and aqueous systems are considered, with particular attention given to anomalous temperature dependencies. Plots depicting the properties of water as a function of temperature show the existence of more or less abrupt changes in thermodynamic and transport parameters at discrete temperatures. The anomalies are considered manifestations of higher order phase transitions in the water. Several examples are given to illustrate the role of structural transitions in water on a number of biologic systems. The problems of temperature effects on membranes and the nature of aqueous interfaces in general are discussed. Summary data, based on a literature review of experimental findings, are presented to show that structural changes in water should be considered in membrane studies. M.G.J.

N68-26600*# Douglas Aircraft Co., Inc., Newport Beach, Calif. Advance Biotechnology and Power Dept.
CHEMICAL AND PHYSICAL PROPERTIES OF HUMAN URINE CONCENTRATES
David F. Putnam Apr. 1968 70 p refs
(Contract NAS1-7104)
(NASA-CR-66612; DAC-59840) CFSTI: HC $3.00/MF $0.65 CSCL 06A

Experimental work was done to provide data on the concentrative properties of human urine. Determinations were made in the ranges 4% to 90% solutes and 70° to 140°F for solute weight fraction, vapor pressure, density, solute concentration, water concentration, solute water ratio, osmolality, osmotic pressure, differential heat of vaporization, differential heat of solution, surface tension, specific conductivity, viscosity, weight fraction of precipitated solids, weight fraction of extracted water, refractive index, and pH. The results are presented in plots of unsmoothed data, empirical equations, and tables of nominal values. Sample calculations and examples illustrating the consideration of these data in engineering design applications are included. Author

N68-26614*# Midwest Research Inst., Kansas City, Mo.
MEDICAL APPLICATIONS OF AEROSPACE SCIENCE AND TECHNOLOGY Final Report, 1 MAY 1967-31 MAY 1968
David Bendersky 31 May 1968 86 p refs
(Contract NASr-63(13); MRI Proj. 3077-E)
(NASA-CR-95100) CFSTI: $3.00/MF $0.65 CSCL 06B

The transfer of aerospace generated technology to applications in the non-aerospace biomedical field are discussed. Procedures have been developed for the efficient and orderly transfer of applicable science and technology and consist of 5 basic steps: (1) define the specific biomedical problem; (2) identify potential

solutions through literature searches, circulation of problem abstracts to research centers and contractors, and personal contacts; (3) modify the original technology, as required, to adapt it to the problem; (4) evaluation of the technology by the investigators who submitted the problem; and (5) document and disseminate information on successful transfers. Covered in this report are 94 biomedical problems submitted by participating medical schools. Based on literature searches and other retrieval techniques, 22 successful technology transfers were possible out of potential solutions for 46 of the problems. Several NASA Tech Briefs pertaining to biomedical devices are included. A.L.

N68-26728*# Aerojet-General Corp., Azusa, Calif.
COMPARATIVE STUDIES OF 90-DAY CONTINUOUS EXPOSURE TO O_3 NO_2 AND CCL_4 AT REDUCED AND AMBIENT PRESSURES Final Report, May 1965–May 1966
J. D. MacEwen, and R. P. Geckler Wright-Patterson AFB, Ohio AMRL Feb. 1968 83 p refs
(NASA Order T-31248-G; Contract AF 33(657)-11305)
(NASA-CR-95106; AGC-3265; AMRL-TR-67-68; AD-669079) CSCL 06F

Ninety-day continuous animal exposures to ozone, nitrogen dioxide and carbon tetrachloride at Threshold Limit Values (TLV) were conducted under ambient pressure and 100% oxygen-reduced pressure (5 psia) conditions. Four species, dogs, monkeys, rats, and mice were exposed to each material. Guinea pigs were also used for ozone exposures due to their reported susceptibility to this pulmonary irritant. Minimal biologic responses were observed with exposure to each of the compounds tested and, consequently, lower tentative exposure limits are recommended for space cabin environments. The recommended limits, based on the time period tested, are 1 ppm for nitrogen dioxide, 0.01 ppm for ozone, and 0.5 ppm for carbon tetrachloride. Author (TAB)

N68-26777*# Miami Valley Hospital, Dayton, Ohio. Dept. of Research.
THE BIOCHEMICAL, PHYSIOLOGICAL, AND METABOLIC EVALUATION OF HUMAN SUBJECTS IN A LIFE SUPPORT SYSTEMS EVALUATOR AND ON A LIQUID FOOD DIET Final Report, 12 Jun. 1964–23 Feb. 1965
Bernard J. Katchman, George M. Homer, James P. F. Murphy, Carol A. Linder, and Vickie R. Must Wright-Patterson AFB, Ohio AMRL Nov. 1967 65 p refs
(NASA Order R-85; Contract AF 33(657)-11716)
(NASA-CR-94860; AMRL-TR-67-72; AD-668127) CFSTI: HC $3.00/MF $0.65 CSCL 06S

A 6-week study with 4 students as volunteer subjects was conducted to evaluate their water, caloric, and protein requirements under simulated stresses of aerospace. The subjects spent 28 days in the Life Support Systems Evaluator; 2 subjects wore the MA-10 space suit, unpressurized, for 8 hrs a day. They ate a 1-cycle, 4 meal per day, fresh food diet and a 1-cycle, 4 meal per day, liquid food diet. The only variety in the fresh food diet was the meat and fruit served at each meal. This diet was highly acceptable and did not show monotony even after 21 days. Flavors were the only variety in the liquid food diet: Cherry, vanilla, chocolate, and strawberry. This diet was unacceptable and monotonous, and less acceptable with time. The fresh food diet contained 81 g of protein, 164 g of fat, 166 g of carbohydrate, and 2329 k cal of energy. The liquid food diet contained 70 g of protein, 167 g of fat, 204 g of carbohydrate, and 2444 k cal of energy. The daily requirement of water was about 3300 ml on the fresh food diet and about 2500 ml on the liquid food diet. The liquid food diet was used less efficiently than the fresh food diet. Consequently, the subjects were in negative balance for calcium, potassium, and phosphorus although the concentrations of these elements in the diet were many times that found in the fresh food diet. The caloric value of the diet could support only a 65 kg man without weight loss. All the clinical data including heart rate, blood pressure, and oral temperature were in the normal range and no significant differences were observed due to confinement in the Life Support Systems Evaluator or due to wearing the unpressurized MA-10 space suit. Author (TAB)

N68-26839*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
THE SALT SPECIFICITY OF AN NADH-OXIDASE ISOLATED FROM AN EXTREME HALOPHILE
L. I. Hochstein and B. P. Dalton [1967] 23 p refs
(NASA-TM-X-60266) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Extracts prepared from an extreme halophile contained an NADH oxidase active at high solute concentrations. The cation requirement was nonspecific since KCl, RbCl, and CsCl replaced NaCl with little or no loss of activity while NH_4Cl was partially effective. Only LiCl failed to replace NaCl. No specific chloride requirement was observed although not all anions replaced chloride. Bromide, nitrate, and iodide were essentially ineffective while acetate, formate, citrate, and sulfate proved suitable. The presence of sulfate affected the ability of a cation to satisfy the solute requirement. It enhanced the rate of NADH oxidation compared to the rate observed in the presence of chloride, and cations which, as chlorides, were inactive (LiCl and $MgCl_2$ at high concentrations) satisfied the cation requirement when added as sulfate salts. While magnesium satisfied the cation requirement, a concentration as well as an anion effect was observed. Author

N68-26845# Library of Congress, Washington, D. C. Aerospace Technology Div.
SOVIET BIOASTRONAUTICS Surveys of Foreign Scientific and Technical Literature, Jul. 1967–Jan. 1968
10 Jun. 1968 199 p refs
(ATD-68-76-108-3)

Abstracts are presented of Soviet research studies in bioastronautics, and a general commentary reviews some of the major accomplishments. Headings for this bibliography include weightlessness and acceleration, noise and vibration, closed cabins and altered gas environment, and hypodynamia and hypokinesia. Effects of combined factors, excluding radiation, are considered; as are hypothermia, biorhythms, and exobiology and spacecraft sterilization. M.W.R.

N68-26850*# Naval School of Aviation Medicine, Pensacola, Fla.
VECTORCARDIOGRAM AND AORTIC BLOOD FLOW OF SQUIRREL MONKEYS *(SAIMIRI SCIUREUS)* IN A STRONG SUPERCONDUCTIVE ELECTROMAGNET
Dietrich E. Beischer 1 Apr. 1968 24 p refs
(NASA Order R-39)
(NASA-CR-94966; NAMI-1036) CFSTI: HC $3.00/MF $0.65 CSCL 06C

In the future, strong magnetic fields will play a significant role in the industrial environment of man. In preparation for this the vectorcardiogram of subhuman primates in strong magnetic fields up to 100,000 Oe was recorded. A pulsating electrical signal (flowgram) was superimposed on the electrocardiogram, providing information on mechanical as well as electrical performance of the heart. No influence of the magnetic field on cardiac activity was observed during short-exposure periods. Author

N68-26869*# Naval School of Aviation Medicine, Pensacola, Fla.
TRANSFER OF HABITUATION OF MOTION SICKNESS ON CHANGE IN BODY POSITION BETWEEN VERTICAL AND HORIZONTAL IN A ROTATING ENVIRONMENT
Ashton Graybiel, Allen B. Thompson, F. Robert Deane, Alfred R. Fregly, James K. Colehour et al 2 Feb. 1968 35 p refs
(NASA Order R-93)
(NASA-CR-95094; NAMI-1029) CFSTI: HC $3.00/MF $0.65 CSCL 06S

The changing symptomatology manifested by four normal young subjects throughout exposure to rotation in a Slow Rotation Room (SRR) was used in studying susceptibility to SRR sickness and transfer effects. A comparison was made between the effects of rotation in the SRR with man parallel (vertical mode) and those when he was at right angles (horizontal mode) to the axis of rotation, the situation in a rotating spacecraft. Attention was focused on motion sickness, ataxia, and the phenomenon of transfer of habituation. Susceptibility to motion sickness was similar in the two orientational modes. Within the limitations of the experiment, the findings regarding SRR sickness indicate that habituation acquired in the SRR in one mode transfers to the other mode. The postrotatory perservation of postural habituation to the rotating environment long after cessation of rotation shed some light on the underlying homeostatic mechanism involved. Author

N68-26914# Texas Univ., Austin. Dept. of Psychology.
OPINION CHANGE AS A FUNCTION OF STRESS AND COMMUNICATOR CREDIBILITY
Robert Helmreich and Harold Sigall Nov. 1967 21 p refs
(Contract N00014-67-A-0126)
(TR-4; AD-668335)

An experiment, investigating the effects of audience stress and communicator credibility on opinion change was conducted. High and low stress and high-relevant, high-irrelevant, and low communicator credibility comprised a 2 X 3 factorial design. The nature of the stress was unrelated to the topic of the communication. Sixty subjects were randomly assigned to one of the six experimental conditions. It was predicted that differences in communicator credibility would lead to differences in opinion change under low stress and that under high stress, opinion change would not be affected significantly by differences in communicator credibility. The results supported these predictions. Author (TAB)

N68-26921# Texas Univ., Austin. Dept. of Psychology.
EFFECTS OF STRESS, COMMUNICATION RELEVANCE AND BIRTH ORDER ON OPINION CHANGE
Robert Helmreich Mar. 1968 15 p refs
(Contract N00014-67-A-0126-0001)
(TR-6; AD-668333)

Subjects under high or low fear were presented with a communication: these under high fear showed significantly greater change on topics both relevant and irrelevant to the source of fear. There was a nonsignificant tendency for first-born Ss to show more change. Fear manipulation was confirmed by 2 stress measures, Mood Adjective Check List and Palmar Sweat Index.
Author (TAB)

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N68-25712*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
IDENTIFICATION OF HUMAN RESPONSE MODELS IN MANUAL CONTROL SYSTEMS
Lawrence W. Taylor, Jr. and A. V. Balakrishnan (Calif. Univ., Los Angeles) 1967 10 p refs Presented at the IFAC Symp. on the Probl. of Identification in Autom. Control Systems, Prague, 12–17 Jun. 1967
(NASA-TM-X-60204) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Frequency domain and time domain methods of analysis are reviewed with regard to their application toward identifying pilot models. The models would subsequently be used to study the stability and performance of a man–machine system in which the human controller performs a compensatory tracking task. Sample linear model results are compared and discussed. The inherent requirement constraining the freedom of the form of the pilot model is also discussed. The time domain method of analysis enables the determination of a nonlinear pilot model. The power spectral density of an ensemble average of the pilot's outputs is used to determine the upper limit on the amount of power associated with a deterministic response. Author

N68-25748*# University of Southern Calif., Los Angeles. Dept. of Electrical Engineering.
ADAPTIVE FINITE STATE MODELS OF THE HUMAN OPERATOR
E. S. Angel [1967] 19 p refs Presented at the USC-NASA Conf. on Manual Control, Los Angeles, 1–3 Mar. 1967
(Grants NGR-05-018-022; AF-AFOSR-1018-67)
(NASA-CR-87264) CFSTI: HC $3.00/MF $0.65 CSCL 05H

While most of the mathematical models of human operators are based on the operator acting in a continuous manner upon continuous data, this model is based upon the human operator seeing only quantized input data and possessing a small number of internal states. The basic model is shown here and a scheme by which the threshold levels might be adjusted to make the basic model adaptive is presented. Some preliminary results and suggestions for further research are also presented. Author

N68-25762# Institute for Perception RVO-TNO, Soesterberg (Netherlands).
SOME POSSIBILITIES FOR IMPROVING THE TRAINING OF RASURA RADAR PERSONNEL [ENKELE MOGELIJKHEDEN TOT VERBETERING VAN DE OPLEIDING VAN RASURA-RADAR-PERSONEEL]
J. A. Michon and E. Alberts 1968 16 p In DUTCH; ENGLISH summary
(IZF-1968-7; TDCK-50261, 2) CFSTI: HC $3.00/MF $0.65

An analysis of the training program for a new type Doppler radar (RASURA) revealed two problem areas requiring further investigation: (1) selection of personnel having the aptitudes for sound detection and identification tasks; and (2) improvement of the sound tape. In addition the analysis revealed weak spots in the training procedure which can be remedied fairly easily. Suggestions to this extent are described. Author

N68-25803# Institute for Perception RVO-TNO, Soesterberg (Netherlands).
PSARP, A PROGRAMABLE SIGNAL AND RESPONSE PROCESSOR
H. van Doorne, A. F. Sanders, and J. Benschop 1968 13 p
(IZF-1968-6; TDCK-50260, 2) CFSTI: HC $3.00/MF $0.65

Experiments on perceptual-motor skills often ask for complex application of standard devices. Combinations of the usual electric or electronic instruments such as signal generators, simple time counters and response recorders cannot always be used to form a sufficiently flexible system for a particular set of experiments. In general, apparatus specially built for a specific experiment does not satisfy the requirements of related investigations and the same device is seldom used again. This paper gives an outline of the principles of a flexible and programable system which meets the requirements of a considerable number of variables. Author

N68-25863 Texas Univ., Austin.
DETECTION PERFORMANCE AND TWO PARAMETERS OF THE AUDITORY STIMULUS
Thomas Lawrence Nichols (Ph.D. Thesis) 1966 77 p
(NASA Order R-129; Contracts Nonr-3579(04) (U); NObsr-93124)
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-3337

Four subjects were run in a conventional yes-no psychophysical experiment in auditory masking. The stimulus consisted of a 250 msec burst of band limited white noise. On 50% of the trials, a 500 Hz sinusoidal signal was added to the noise burst. On each trial, a record was made of the nature of the stimulus, the subject's response latency, the nature of his response, and two physical measures of the stimulus waveform. The two physical measurements were made using an electronic ear model consisting of a narrow band filter (simulating the subject's critical band) followed by a rectifier and two measurement devices. The results indicate that gradations in stimulus level, whether a signal is present or not, produce gradations in response probability and latency in a continuous fashion. These results are in opposition to classical threshold theory, and support the formulations of the Theory of Signal Detectability. Dissert. Abstr.

N68-25973# Library of Congress, Washington, D. C. Aerospace Technology Div.
AEROSPACE LIFE SUPPORT SYSTEMS Surveys of Foreign Scientific and Technical Literature, 1966–1967
B. Mandrovsky 12 Jun. 1968 60 p refs
(ATD-68-42-22-3)

Based on the volume of Chlorella research in the U.S.S.R., it appears that Soviet researchers have apparently committed themselves to its use as a basis for a biological regenerative system for life support in space flight. A commentary is presented on the various aspects of research being conducted by university teams, and abstracts are included on 49 Soviet and satellite open source documents published in 1966–1967. A.L.

N68-26041 Michigan Univ., Ann Arbor.
EFFECTS OF STIMULUS DURATION AND INTER-STIMULUS INTERVAL ON THE PATH OF PERCEIVED MOTION
Howard Gadlin (Ph.D. Thesis) 1966 127 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8253

The study reported is a parametric investigation of apparent *Beta* motion under conditions in which Ss were relatively free of expectations with respect to the perception of motion. Four experiments were designed to determine the effects of variations in the temporal values of stimulus duration (D) and inter-stimulus interval (ISI) on the path of phenomenal motion. The stimulus display employed 4 individual lights, arranged describe a square with sides of 3 or 6 in. Each trial consisted of 5 cycles through the 4 lights presented successively, a total of 20 light presentations. D and ISI were held constant within a trial. For all Ss there were 4 blocks of 10 trials each, 2 on Day 1 and on Day 2. Within a given block of trials, the temporal values of ISI and/or D varied from trial to trial in 25 msecs. steps between 50 and 275 msecs. S's task was to describe the stimulus patterns presented, with particular reference to the perceived size and shape of the pattern. The experiments were designed to allow assessment of the effects of (1) order of presentation: random vs. ascending or descending variation of temporal values; (2) stimultaneous vs. independent variation of ISI and D; (3) inter-stimulus distance. Dissert. Abstr.

N68-26158*# University of Southern Calif., Los Angeles.
AN ASYNCHRONOUS PULSE-AMPLITUDE PULSE-WIDTH MODEL OF THE HUMAN OPERATOR
M. J. Merritt and G. A. Bekey 1967 28 p refs Presented at the USC-NASA Conf. on Manual Control, Los Angeles, 1–3 Mar. 1967
(Grant NGR-05-018-022)
(NASA-CR-87265) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The development of a human operator model which produces discrete outputs in response to continuously presented Gaussian random inputs is described. Actual human operator output was converted to an idealized human operator output, represented by a sequence of three-tuples: time of the pulse initiation, pulse amplitude, and pulse width. Details are given on the compensatory tracking task experiment. The human operator model is based on intuitive concepts of human operator behavior and an examination of the tracking record, and on the assumption that the operator generates an output consisting of a series of modulated pulses. Possible quantitative relationships between the input quantities (error and error rate) and the output pulse events are investigated. Computational results indicate: (1) The delay time between the model's decision to pulse and the actual event was 200 milliseconds. (2) The pulse amplitude and pulse width models for negative pulses produce better correlations with the experimental data than the models for positive pulses. A.L.

N68-26208*# National Aeronautics and Space Administration, Washington, D. C.
BIOREGENERATIVE LIFE-SUPPORT SYSTEMS
Dale W. Jenkins *In its* Bioregenerative Systems 1968 p 1–6 refs (See N68-26207 15-04)

Two types of biological regenerative systems for the closed ecological life support during manned space flight are proposed: photogeneses of algae or higher plants, and *Hydrogenomonas* bioregenerative life support systems. In the photosynthesis process, light energy is used to split water and a heavy loss must result if only artificial light is available for converting electricity into visible light. The chemosynthetic process combines the water electrolysis with the growth of the *Hydrogenomonas eutropha* bacteria; respiration water from the astronaut and water produced by the bacteria are both used in the electrolysis. Tentative power and weight requirements for both chemical and biological regenerative life-support systems during a three man 270 day flight mission are shown in table form. G.G.

N68-26255# Joint Publications Research Service, Washington, D. C.
HUMAN REACTIONS TO STRESS IN SPECIFIC SITUATIONS
B. F. Lomov 5 Jun. 1968 29 p refs Transl. into ENGLISH from the book "Problemy Inzhenernoy Psikhologii" Nauka, Moscow, 1967 p 58–78, 82–86
(JPRS-45562)

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2. CHANGES IN THE RATE OF INFORMATION PROCESSING BY FLIGHT PERSONNEL DURING EXTENDED FLIGHTS E. V. Bondarev, G. I. Gurvich, T. T. Dzhamgarov, V. A. Yegorov, V. L. Marishchuk et al p 23–28 refs (See N68-26257 15-05)

N68-26256# Joint Publications Research Service, Washington, D. C.
METHODS OF DETERMINING THE DEGREE OF STRAIN IN THE WORK OF THE HUMAN OPERATOR
N. I. Nayenko and O. V. Ovchinnikova *In its* Human Reactions to Stress in Specific Situations 5 Jun. 1968 p 1–22 refs (See N68-26255 15-05)

Various concepts of psychic stress are reviewed, and the problems of creating a stress situation under laboratory conditions are discussed. The negative behavioral changes occurring during stress are examined as a basis for defining objective indices for evaluating research techniques. Experimental data show that the states of emotional stress are characterized by disruptions of the motor system, expressed in general muscular constraint, in tremors, and uncoordinated movements. Indicators of vegetative changes include variations in breathing frequency, cardiac contractions, cutaneous-galvanic reactions, arterial pressure, perspiration, skin temperature, etc. The difficulties of evaluating electroencephalograms to determine tension in man are discussed, along with the problems of assessing biochemical changes. Several categories of stressed states are defined for experimentally reproducing stress situations; the importance of including motivation as an independent factor is emphasized. Examples of stress studies on the performance of human operators in automated control systems are included. A.L.

N68-26257# Joint Publications Research Service, Washington, D. C.

CHANGES IN THE RATE OF INFORMATION PROCESSING BY FLIGHT PERSONNEL DURING EXTENDED FLIGHTS

E. V. Bondarev, G. I. Gurvich, T. T. Dzhamgarov, V. A. Yegorov, V. L. Marishchuk et al. *In its* Human Reactions to Stress in Specific Situations 5 Jun. 1968 p 23–28 refs (See N68-26255 15-05)

Light, sonic, and tactile signals were used to study the rate of information processing by flight crews. The experiments were conducted on all flight crew members under laboratory conditions, in the cabin of the aircraft prior to flight, and every 3 hours during the 15 hour flights. As fatigue developed, the level of the functional lability of the personnel lead to a retardation of reactions, an increase in errors, and a reduction in the rate of information processing. Data indicate that this decrease of processing rate due to fatigue was noted first among individuals whose activity was most strenuous and demanding. The rate of information processing during the stimulation periods comprised a fairly sensitive index, characterizing the extent of the development of fatigue of various analyzer systems. Evidence indicates that there exists an optimal rate of information processing, at which the required precision of the reactions is combined with sufficient rapidity. A.L.

N68-26311# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

AIRCREW COOLING STUDY

Frederick Jurgens Jan. 1968 180 p refs
(Contract NOw-62-0604-c)
(TG-945; AD-668139)

The naval aviator cannot wear separate garments for the wide variety of thermal environments in which he must work. The results of a study conducted to ascertain the thermal control requirements of these aircrewmen are presented. The study set out to define the heat and moisture removal requirements during ground and flight operations, to learn the effects of various clothing combinations, and to learn the effects of flight conditions on thermal moisture control. The effects of both metabolic activity and environment on body temperature are considered, and various techniques of air and liquid cooling in a variety of garments are then reviewed in order to determine the most effective ways of keeping body temperatures at reasonable levels. Immediate use of forced-air cooling suits, more precise determination of the limits of tolerable working conditions, and further improvements in the design of liquid-cooled garments are recommended. Author (TAB)

N68-26312# Naval Training Device Center, Orlando, Fla. Training Technology Dept.

AUTOKINESIS AND FELT EYE POSITION Final Report

Stephen Jordon Mar. 1968 62 p refs
(NAVTRADEVCEN-IH-142; AD-668015)

The experimental results indicate that autokinesis may be explained within the context of Dunckers theory of relative displacement. The nature of the displacement was found to be, in these experiments, a shift in the egocentric visual framework as mediated by felt rather than objective eye position. An explanation of the shift in felt eye position based on a change in afferent stimulation impinging on the eye is proposed. Implications of the theory for future research including an investigation of auditory autokinesis and felt head position are discussed. Author (TAB)

N68-26321 Rochester Univ., N. Y.

THE SPECTRAL SENSITIVITIES OF RECEPTOR SYSTEMS IN HUMAN COLOR VISION

Carl R. Ingling, Jr. (Ph.D. Thesis) 1967 172 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-8957

This investigation concerns the spectral sensitivities of receptor systems mediating human foveal color vision. Only that work which is thought to deal with these sensitivities at or quite close to the receptor level is considered. The emphasis of the literature review and discussion is on testing the convergence of a few selected, and different, approaches, rather than on comprehensiveness. From this review, it is concluded that, to a first approximation, the spectral sensitivities of the blue and green systems show a fair consistency between methods, but this is not true for the red. The experimental work is in two parts: in the first, some early results of a program of replication, dealing mostly with the red and green systems, are reported; in the second, the first use of a psychophysical method, called the "cancellation method," is applied to the determination of the red system spectral sensitivity. In general, the experimental results obtained support the reality of the complex structure indicated for the red system by the comparison of other studies in the literature. It is suggested that part of this complexity may be due to a second red pigment in the red channel. Dissert. Abstr.

N68-26382# Army Aeromedical Research Unit, Fort Rucker, Ala.

SOUND ATTENUATION CHARACTERISTICS OF THE NAVY BPH-2 HELMET

Robert T. Camp, Jr. Mar. 1968 25 p refs
(USAARU-68-6; AD-667959)

An evaluation of the real-ear sound attenuation characteristics of the Navy BPH-2 helmet was done with procedures and equipment specified by ASA Z24.22-1957. The results show that the BPH-2 has acoustical characteristics superior to the standard Army APH-5 at frequencies from 125 Hz through 1000 Hz. In view of the high attenuation in the speech communications spectrum, it is recommended that this helmet be considered for use by the U. S. Army. Author (TAB)

N68-26384# Tracor, Inc., Austin, Tex.

STUDIES OF BINAURAL INTERACTION

Thomas R. Evans 1 Apr. 1968 56 p refs
(Contract Nonr-4193(00))
TRACOR-68-593-U; AD-668337)

Basic studies of binaural interaction were continued. The areas of research pursued concerned the determination of the critical bands for antiphasic signals under various intensive conditions, the effect of signal duration on critical bands, the effect of harmonic relations on the detection of signals of uncertain frequency, and the influence of various auditory parameters on the cortical evoked response. Author (TAB)

N68-26501# Advisory Group for Aerospace Research and Development, Paris (France).
ACCELERATION TERMINOLOGY: TABLE OF COMPARATIVE EQUIVALENTS
In its Principles of Biodyn. as Appl. to Manned Aerospace Flight. Sect. A [1968] 6 p refs (See N68-26500 15-04)

Effects of the development of vertical or steep-landing and takeoff aircraft, helicopters, and space vehicles on the terms that could be used for describing the forces and accelerations imposed on the vehicle and occupants are discussed. With the advent of these recent advances, it became desirable that essentially two directional terminologies be used, one for the vehicle and another for the occupants. Terms were evolved and incorporated in revised tables of equivalent terminology for both linear and angular motion. It was determined that the relationship between the directions of the forces applied to the vehicle and the directions of the resulting forces, accelerations, kinetic reactions, and relative motions of the occupants could be simplified by organizing these into the form of the laws of motion. Two tables were devised listing the terms to be used in describing linear and angular motion, respectively. The construction of these tables and their use are described. A.L.

N68-26503# Advisory Group for Aerospace Research and Development, Paris (France).
THE DYNAMICS OF ROTATION APPLIED TO CENTRIFUGES
In its Principles of Biodyn. as Appl. to Manned Aerospace Flight. Sect. A [1968] 14 p (See N68-26500 15-04)

As an aid to physicians and medical officers terms most commonly used in association with rotational physics are defined. Because of the frequent necessity for converting units, a short discussion on dimensional equivalence and conversions is included. The effects of uniform and nonuniform angular motion on the magnitude and direction of the total acceleration vector are described. Coriolis acceleration of a rotating body is discussed, and some examples of its effects are given. A.L.

N68-26602# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
THE MYOTRON: A SERVO-CONTROLLED EXOSKELETON FOR THE MEASUREMENT OF MUSCULAR KINETICS Final Technical Report
J. Sam Miller 1 May 1968 53 p refs *Its* Internal Res. Proj. 86-198
(CAL-VO-2401-E-1)

The Myotron is a new type of instrument for the dynamic measurement of skeletal muscle forces and behavior. It is basically a servo-controlled exoskeleton with integral force and position transducers (non-myoelectric). A two-axis instrument was designed and fabricated to establish the practicality and medical utility of such a device. In-hospital evaluation of the instrument as a medical research aid substantiated that the device is potentially suited for basic studies of neuromuscular activity, studies of neuromuscular disorders, development of new rehabilitation therapy techniques, and studies of new powered orthotic devices. This report introduces the Myotron concept and describes the construction and operational principles of the two-axis instrument. The evaluation experiments and results are presented, with recommendations for further research. A selected bibliography is appended. Author

N68-26679# Dayton Univ., Ohio. Research Inst.
SPEECH IN AN ARTIFICIAL ATMOSPHERE (30% HELIUM-70% OXYGEN) Final Report, Oct. 1965-May 1967
Charles W. Nixon, William E. Mabeon (School of Aerospace Med.), Frank Trimboli, and B. E. Welch (School of Aerospace Med.) Wright-Patterson AFB, Ohio AMRL Dec. 1967 38 p refs
(Contract AF 33(615)-1135)
(AMRL-TR-67-125; AD-669089)

During a simulated space mission, speech was analyzed to investigate the effects on communication of a 56-day exposure to a cabin atmosphere composed of 30% helium and 70% oxygen at an altitude of 27,000 feet. Results of physical and subjective analyses indicated: (1) Word intelligibility was satisfactory so long as the level of ambient noise in the speech frequency range did not exceed the speech level. (2) Fundamental frequency remained relatively unaffected by the 30% helium-70% oxygen gas mixture. (3) Mean second and third formant frequencies were 1.109 and 1.079 times higher in the helium exposure than in the initial ground level condition. (4) There was no adaptation in formant frequency shift as a function of time in the helium mixture, however, some persistency effects were seen during the post-exposure condition. (5) Calculated velocity of sound ratios were found to overestimate the measured amount of formant shift by a mean factor of 0.05 for the 30% helium mixture. (6) Speech quality was judged to deteriorate with increased duration of exposure to the 30% helium mixture. Comparisons were made between these findings and the results of a previous study which investigated speech produced in a 56% helium-44% oxygen atmospheric mixture.
Author (TAB)

N68-26690*# Systems Technology, Inc., Hawthorne, Calif.
PILOT DYNAMIC RESPONSE TO SUDDEN FLIGHT CONTROL SYSTEM FAILURES AND IMPLICATIONS FOR DESIGN
David H. Weir and Walter A. Johnson Washington NASA Jun. 1968 152 p refs
(Contract NAS2-3607)
(NASA-CR-1087; TR-165-1) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The dynamic response of the human pilot is studied during sudden changes in the effective controlled element dynamics caused by flight control system failure. Experimental results from single-loop and multiple-loop fixed-base studies are presented. A hypothesis of graceful degradation is shown to be valid which states that the pilot's transition response and performance are improved if the difference in controlled element dynamics at failure is reduced. The design implications of this principle are detailed. A model for the pilot's dynamic response is presented which accounts for his behavior during the several phases of transition. Author

N68-26701*# Webb Associates, Yellow Springs, Ohio.
AUTOMATIC CONTROL OF WATER COOLING IN SPACE SUITS
Paul Webb, James F. Annis, and Samuel J. Troutman Washington NASA Jun. 1968 91 p refs
(Contract NASw-1529)
(NASA-CR-1085) CFSTI: HC $3.00/MF $0.65 CSCL 06K

Accurate and timely control of the powerful cooling available in a water cooled garment (WCG) is important during periods when work varies widely, as in extravehicular activity, and with it the need for cooling. The relationship between metabolic rate (MR) and the suit inlet water temperature (T_{wi}) can be expressed as an ordinary differential equation: $\tau \dot{T}_{wi} = -T_{wi} + B_4(MR_0 - MR)$. An experimental Q controller was used to automatically control heat removal (Q) from men wearing a new WCG while working on a treadmill. The input to the controller was a continuous oxygen consumption signal. The cooling water was recirculated through a closed loop where the man was the heat source and a controllable thermoelectric cooler was the heat sink. After initial experiments where variation in the controller gain and time constant were explored, automatic control was evaluated in two subjects doing four different patterns of work, including brief periods of intermittent work. Physiological responses were good, and control was smooth and accurate. Author

N68-28780# Electro-Optical Systems, Inc., Pasadena, Calif. Biomedical Instrumentation Dept.
PHYSIOLOGICAL INSTRUMENTATION FOR FREE RANGING CHIMPANZEES Final Summary Report, Jul. 1966–Oct. 1967
R. H. Russell Holloman AFB, N. Mex. Aeromed. Res. Lab. Apr. 1968 93 p refs
(Contract AF 29(600)-5755)
(ARL-TR-68-1; AD-668073)

Research and development necessary for the fabricating of four chronically implantable instruments is described. The complete instrument comprises conditioning for low level biopotential signals, temperature sensing, two subcarrier oscillators (IRIG channels No. 9 and 10), a VHF transmitter using FM/FM multiplexing with a range of 1200 feet, a remote switch to activate the instrument and a saturated mercury battery of 500 mAH capacity. The VHF receiving station, including the antenna, was supplied as part of the program. Prime design goals were met such as transmitting range, and IRIG and FCC compatability; the design goal for power consumption was bettered by more than two times to give a powered lifetime of more than 30 days. Author (TAB)

N68-26866# National Bureau of Standards, Washington, D. C. Inst. for Basic Standards.
COLORIMETRY
I. Nimeroff Jan. 1968 48 p refs
(NBS-Monograph-104)

The definition of color, as a characteristic of light, and the basic principles of its measurement are given. The reduction of spectrophotometric data to three chromaticity coordinates by means of the three-function CIE standard observer system for colorimetry is described. Various methods of direct colorimetry, and visual and photoelectric methods of colorimetry by differences from material standards are treated. The most useful collections of material color standards are described and the most widely used one-dimensional color scales are explained. The limitations of several colorimetric methods spectrophotometric, photoelectric, and visual, are discussed. Author

N68-26922 Stanford Univ., Calif.
SOME EFFECTS OF CONSONANT CONTEXT, FILTERING, AND NASAL OCCLUSION OF PERCEIVED NASALIZATION
Norman Rex Dixon (Ph.D. Thesis) 1967 192 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-7909)

The present study is an investigation of the effects of anterior nasal occlusion, consonant context, and filtering on the perception of nasalization. Four sentences were constructed to represent a descending degree of overall contextual nasalization, as a function of consonant context, from the first to the fourth. Utterance was sent through several filtering conditions: low-pass at 500, 1000 and 1500 cps; high-pass at 1500, 2000 and 2500 cps; band-pass at 500–1000, 1000–1500 and 1500–2000 cps; and full-pass through the filter circuit. The observed shift to perceived hypernasality as a function of low-pass or band-pass filtering probably results from rendering nasalization-related low-frequency energy already existing in the utterance more prominent perceptually. In any perceptual description of hyponasality or cul-de-sac, and/or mixed nasality, contextual nasalization must be considered. In General American speech, acoustico-articulatory-perceptual relationships are extremely complex and involve the total speech event, including so-called "non-nasal" portions. Dissert. Abstr.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N68-25655# Los Alamos Scientific Lab., N. Mex.
INVESTIGATION OF TWO METHODS FOR MEASURING FREE ACID IN PLUTONIUM SOLUTIONS
J. W. Dahlby, G. R. Waterbury, and C. F. Metz 12 Mar. 1968 8 p refs
(Contract W-7405-ENG-36)
(LA-3876) CFSTI: HC $3.00/MF $0.65

The reliabilities of two methods for measuring free acid in plutonium solutions were determined by applying each to the analysis of plutonium, thorium, and cerium solutions having known free acid concentration. In the iodate method, the hydrolyzable ion was precipitated with iodate and separated by filtration, and the free acid in the filtrate was titrated with standard base. In the citrate method, the hydrolyzable ion was complexed with citrate during the titration of the free acid with standard base. Between 99 and 100% of the free acid in plutonium(IV) solutions was measured using the iodate method, and high results, 106 to 109%, were obtained using the citrate method. Neither was reliable for determining free acid in plutonium(III) solutions; the iodate method gave low results (94 to 96%), and the citrate method gave high results (108 to 109%). Author (NSA)

N68-25658# Oak Ridge National Lab., Tenn. Chemistry Div.
X-RAY DIFFRACTION DATA ON THE SYSTEM WATER-AMMONIA AT 4°C
A. H. Narten Mar. 1968 53 p refs
(Contract W-7405-ENG-26)
(ORNL-4221) CFSTI: HC $3.00/MF $0.65

The scattering of X-rays from the free surface of aqueous solutions containing 18.3 and 28.5 mole % NH_3 and of pure ammonia was measured and analyzed at 4°C. Both the raw data and the intensity and radial distribution functions derived from them are presented in tabulated form. The curves for the ammonia–water system are compared with previously obtained results for pure water at the same temperature. Author (NSA)

N68-25662# Iowa State Univ. of Science and Technology, Ames.
KINETIC STUDY OF THE REDUCTION OF $NbCl_5$ BY NIOBIUM METAL USING A GAS CHROMATOGRAPH
D. J. Lorine and F. D. Stevenson Feb. 1968 17 p refs
(Contract W-7405-ENG-82)
(IS-1780) CFSTI: HC $3.00/MF $0.65

An introductory study of the reduction of $NbCl_5$ by niobium metal in a gas chromatograph demonstrated that the reduction is first order with respect to $NbCl_5$ concentration at temperatures in the vicinity of 500°C. The temperature dependence of the rate constant between 350 and 500°C was also determined. The application of dual column gas chromatographs for reduction studies where no volatile products are formed is demonstrated. Author (NSA)

N68-25688*# National Aeronautics and Space Administration, Washington, D. C.
KINETICS OF THE THERMAL DISSOCIATION OF SILVER NITRITE [KINETIK DER THERMISCHEN DISSOZIATION DES SILBERNITRITS]
M. Blumenthal and T. Checinski May 1968 9 p refs Transl. into ENGLISH from Intern. Acad. Polonaise Sci. Lettres. Classe Sci. Mat. Naturells. Ser. A: Sci. Mat. (France), v. 1935A, 1935 p 166–173
(NASA-TT-F-11732) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Kinetics of the thermal decomposition of silver nitrite was studied. The reaction takes place in two stages: (I) $AgNO_2 \rightarrow Ag + NO_2$ and (II) $NO_2 + AgNO_2 \rightarrow AgNO_3 + NO$. The velocities of both reactions depend on the pressure. The reaction takes place according to a first order equation when performed in vacuum, but under atmospheric pressure, the equation is of second order. The

order of equation becomes lower as the temperature rises. An induction period that appears in the vicinity of the equilibrium state becomes more pronounced with higher temperature. It vanishes at a certain distance from the temperature of equilibrium. Author

N68-25670# Los Alamos Scientific Lab., N. Mex.
THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. 12: CHROMIUM
D. F. Bowersox 11 Mar. 1968 5 p refs
(Contract W-7405-ENG-36)
(LA-3850) CFSTI: HC $3.00/MF $0.65

The reversibility of the Cr–Pu system was demonstrated at low Cr concentrations. The solubility increased from 0.36 wt % Cr at 700°C to 2.00 wt % Cr at 1000°C. The data fit the equation $\log N_{Cr} = 1.32 - 3.03 \times 10^3 T^{-1}$, where N_{Cr} is the mole fraction of Cr in a saturated solution at absolute temperature T. Author (NSA)

N68-25690# Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.
THE MOLYBDENUM HEXAFLUORIDE–HYDROGEN FLUORIDE TRIPLE POINT CURVE AND ITS APPLICATION TO A METHOD OF ANALYSIS
W. D. Hedge 22 Mar. 1968 22 p refs
(Contract W-7405-ENG-26)
(K-1698) CFSTI: HC $3.00/MF $0.65

The triple point curve for the binary system molybdenum hexafluoride–hydrogen fluoride was determined over the range of 0.0 to 5.0 mole percent hydrogen fluoride. This system is represented by the following general equation: $\Delta t = A(N_2) + B(N_2)^2 + C(N_2)^3$, where Δt is the depression of the triple point of pure molybdenum hexafluoride in degrees centigrade, N_2 is the mole fraction of hydrogen fluoride, and A, B, and C are constants with $A = 159.86 - 129.19(R) + 36.44(R)^2$, $B = -3624.5 + 2965.0(R) - 407.5(R)^2$, and $C = 26239.0 - 17875.0(R) - 1796.2(R)^2$. R is the ratio of liquid volume to total volume. The deviations resulting from non-ideality are discussed. Corrections for these deviations are applied by extrapolation of observed triple point depressions and ratios of liquid volume to total volume as represented by the above general equation. A method is also presented to estimate the liquid, gross, and vapor compositions. Author (NSA)

N68-25700# Argonne National Lab., Ill. Chemistry Div.
TABLES FOR THE EVALUATION OF DECAY CURVES OF A CHEMICAL SPECIES UNDERGOING SIMULTANEOUS FIRST AND SECOND ORDER DECAY
Klaus H. Schmidt Dec. 1967 17 p refs
(Contract W-31-109-ENG-38)
(ANL-7400) CFSTI: HC $3.00/MF $0.65

Tables were computed to facilitate the determination of the first- and second-order components of the decay curve of a chemical species from two measured half-lives. NSA

N68-25701# Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.
GEL-ADDITION PROCESS CHEMICAL STUDIES Quarterly Progress Report, 1 Jul.–31 Oct. 1967
E. H. Dewell, comp. Feb. 1968 59 p refs
(Contract AT(30-1)-3714)
(BAW-3714-5; QPR-5) CFSTI: HC $3.00/MF $0.65

Development of the Gel-Addition process for mixed plutonia–urania reactor fuels has continued. Various contacting techniques were tested for injecting plutonium into UO_2 gel spheres. Agitated-batch tests showed that 800-micron spheres are mechanically strong enough to withstand gentle agitation; contacting at 54°C does not materially increase the total pickup of hexavalent plutonium. Packed-column tests showed increased pickup of hexavalent plutonium with repeated contacting. A 20-gram bed of UO_2 gel was built up to 12% (Pu/U + Pu) by contact with three fresh samples of 0.92 M Pu(VI) at pH ≈ 4. The bed was dried between contacts. Oxidation was severe. Organic residues from the gelation process do not interfere strongly with plutonium pickup. EDTA complexometric titration and coulometric titration gave good agreement on the plutonium assay of U–Pu mixed solutions. Organic interference in plutonium coulometry can be eliminated by boiling the platinum electrode in nitric acid. A shakedown of the apparatus is complete for particle characterization by mercury and gas pycnometry, tap density measurement, particle crush strength determination, differential thermal analyses, and sorbed gas measurement. Ceramographic examination of unfired gel is used routinely to establish proper desiccant conditions for gel formation. Autoradiography on organic thin films has shown that Pu(VI) tends to remain on the sphere surface while Pu(III) permeates the entire sphere. The capsule design and the safety analysis for reactor testing of mixed fuels are complete. Initial exposure will verify thermal and nuclear calculations. The irradiation program is under revision. All sol and gel preparation work has been transferred to a new task, which is intended to establish a pilot plant capability for industrial production of $(U,Pu)O_2$ particulate fuel. The mixed sol approach will be used. Author (NSA)

N68-25706# Mound Lab., Miamisburg, Ohio.
MOUND LABORATORY PROGRESS REPORT FOR CHEMISTRY: APRIL–JUNE 1967
25 Jan. 1968 36 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1417) CFSTI: HC $3.00/MF $0.65

Progress is reported on research on: half-life determination by decaying pairs, residue adsorption, alpha–beta branching ratio of ^{227}Ac, radiochemistry of osmium, ^{234}U recovery, ^{229}Th recovery, ^{227}Ac production, techniques for measuring internal conversion coefficients, crush strength apparatus, x-ray diffraction of rubidium uranyl nitrate, and determination of organic materials in water. NSA

N68-25752# International Lab. of Genetics and Biophysics, Naples (Italy).
REPORT OF ACTIVITIES OF THE INTERNATIONAL LABORATORY OF GENETICS AND BIOPHYSICS, JANUARY 1–DECEMBER 31, 1966
Brussels EURATOM Apr. 1968 107 p refs
(Contract EURATOM-012-61-12 BIAI)
(EUR-3912.e) CFSTI: $3.00

Following is a brief summary of the main research carried out in the Laboratory of Genetics and Biophysics: regulation of viral functions in various types of bacteriophage; process of integration of temperate viruses; organization and genetic behavior of the genes for ribosomal RNA in *Drosophila;* protein synthesis and the characterization of gene products; use of human material for the study of evolution; somatic cell variation *in vitro* and its genetical determination; biochemistry of cell growth and cell differentiation; regulation of gene function and recombination of molecular level; molecular basis of cell differentiation and the role of the cell nucleus in morphogenesis and protein synthesis; studies on ribosomes; research on polyoma, mouse leukemia virus group and the avian leukosis viruses; and RNA biosynthesis in mammalian brain and on the possible effects of some functional states on this process. Author

N68-25791# California Univ., Livermore. Lawrence Radiation Lab.
DETERMINATION OF RARE EARTHS AND FLUORIDES IN RARE EARTH FLUORIDES
L. P. Rigdon and W. E. Sunderland 31 Jan. 1968 10 p refs
(UCRL-50383)

A technique was developed for assaying rare earths and fluorides in refractory rare earth fluoride samples. For fluoride determination, a portion of the sample is fused with NaOH in a platinum crucible and the melt is dissolved in water. The solution is transferred to a cation exchange column in the hydrogen form, the fluoride is eluted as HF with water, and the fluoride determination is made indirectly by titration of the HF with standard NaOH. For rare earth determination, a separate portion of sample is fused with potassium pyrosulfate and dissolved in water; the determination is made by titration with EDTA. Recommended procedures for both constituents and data from the analysis of 14 samples are presented. The relative standard deviation is 0.6% for fluorides and 0.4% for rare earths. Author (NSA)

N68-25808# United Kingdom Atomic Energy Authority, Windscale (England). Production Group.

A PRECISE AMPEROMETRIC TITRATION FOR THE DETERMINATION OF URANIUM USING FERROUS SULPHATE AS REDUCTANT

J. Cherry 1968 16 p refs

(PG-827(W)) HC $3.00/MF $0.65

The titrimetric method of Davies and Gray for the determination of uranium in nitric acid has been modified by the introduction of amperometric end-point detection, with a consequent improvement in the precision and sensitivity. The use of sulphuric acid solution as diluent instead of water, enables the method to be used for the determination of uranium in plutonium solutions. Author

N68-25832# Atomic Energy Commission Research Establishment, Riso (Denmark).

INFLUENCE OF DOSE RATE AT LARGE ABSORBED DOSES ON THE OXALIC-ACID DOSIMETER

Ivan G. Draganic, Knud Sehested, and Niels W. Holm Aug. 1967 19 p refs

(RISO-112) CFSTI: HC $3.00/MF $0.65

A number of experiments dealing with the influence of high dose rates on the oxalic-acid dosimeter are described. A pulsed electron linear accelerator was used as radiation source. It is shown that the system may be used at dose rates up to 10^{10} rads/sec when an adequate initial concentration is applied and the irradiation field is reasonably homogeneous. Author

N68-25854# Bureau of Mines, Albany, Oreg. Metallurgy Research Center.

HIGH-PURITY VANADIUM BY METALLOTHERMIC REDUCTION OF VANADIUM TRICHLORIDE

Michael J. Ferrante, F. E. Block, and J. L. Schaller Jul. 1968 23 p refs

(BM-RI-7145)

The preparation and subsequent reduction of vanadium trichloride was investigated as a process for the production of high-purity vanadium metal. Chlorine was reacted with vanadium oxide in the presence of carbon to form vanadium tetrachloride. The contaminant vanadium oxytrichloride was also formed and later converted to tetrachloride by reaction with chlorine in the presence of activated charcoal. Vanadium tetrachloride was stirred continuously during thermal dissociation to vanadium trichloride powder from which volatile contaminants were removed by distillation. The vanadium trichloride powder was reduced to vanadium sponge by controlled feeding of the trichloride into molten magnesium. Excess reductant and byproduct salt were removed from the vanadium sponge by high-vacuum distillation. Batches as large as 6.5 kilograms of sponge metal were prepared at an average reaction efficiency of 98 percent. Vanadium sponge after consolidation by arc-melting contained 820 to 1,330 ppm of interstitial impurities and had a hardness between Rockwell B 40 and 70. This metal exhibited excellent workability at room temperature. The purification of impure vanadium metal by electron-beam melting resulted in lowering interstitial impurities from 1,890 to 504 ppm and hardness from Rockwell B 87 to 28. Author

N68-25890# Union Carbide Nuclear Co., Oak Ridge, Tenn. Gaseous Diffusion Plant.

THE TRIPLE POINT DEPRESSION CURVES FOR THE BINARY SYSTEMS TUNGSTEN HEXAFLUORIDE IN URANIUM HEXAFLUORIDE AND MOLYBDENUM HEXAFLUORIDE IN URANIUM HEXAFLUORIDE: THEIR APPLICATION TO METHODS OF ANALYSES

W. D. Hedge 22 Mar. 1968 20 p refs

(Contract W-7405-ENG-26)

(K-1697) CFSTI: HC $3.00/MF $0.65

The triple point depression curves for the binary systems tungsten hexafluoride–uranium hexafluoride and molybdenum hexafluoride–uranium hexafluoride were determined over the range of 100.0 to 98.5 mole percent uranium hexafluoride. The observed data are represented by the following general equations obtained by the least squares method: WF_6–UF_6. $N_2 = (\Delta t) \exp [-4.2114 + 0.2001(R)]$ and MoF_6–UF_6. $N_2 = (\Delta t) \exp [-4.0357 + 0.0252(R)]$ where N_2 is the mole fraction of solute, (Δt) is the triple point depression in °C, and R is the ratio of liquid volume to total volume. The deviations resulting from non-ideality are discussed. Corrections for these deviations are applied by extrapolation of observed triple point depressions and ratios of liquid volume to total volume. A method is presented to estimate the liquid, gross, and vapor compositions. Author (NSA)

N68-25908 Iowa State Univ. of Science and Technology, Ames.

A STUDY OF THE EFFECTS OF IMPURITIES AND VACANCIES ON NUCLEAR MAGNETIC RESONANCE LINE SHAPES IN INTERMETALLIC COMPOUNDS

Ronald Glen Lecander (Ph.D. Thesis) 1967 182 p

(Contract W-7405-ENG-82)

(IS-T-122) Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-8920

Nuclear magnetic resonance (nmr) line shapes were analyzed to obtain the local variation of the hyperfine interaction due to impurities or vacancies in intermetallic compounds. The line shape of the Sc^{45} nmr was studied in $Sc(Ni_{1-x}Co_x)_2$. For low cobalt concentrations, these line shapes were described by an inhomogeneous Knight shift due to the hyperfine interaction within oscillating charge density surrounding the cobalt atoms. A long range interaction was necessary to describe the average Knight shift variation with composition. This shift was positive for low cobalt concentrations and became negative for very high cobalt concentrations. The nmr of V^{51} was studied at room temperature in VC_x non-stoichiometric compounds for $0.75 < x < 0.88$. The shape of the resonance in $VC_{0.88}$ and the variation of the average Knight shift as a function of the carbon vacancy concentration was described by a hyperfine interaction due to first nearest neighbor carbon vacancies. An unsuccessful attempt was made to explain this local interaction. A negative Knight shift of −0.187% was obtained for V^{51} in stoichiometric VC. Dissert. Abstr.

N68-25913# Technische Hochschule Munchen (West Germany).

THE REPRESENTATION OF CARBIDES IN LITHIUM CYANIDE AND DILITHIUM CYANAMIDE FUSIONS [DIE DARSTELLUNG VON CARBIDEN IN LITHIUM-CYANID- UND DILITHIUMCYANAMID-SCHMELZEN]

Ernst Roth (Ph.D. Thesis) [1967] 72 p refs In GERMAN

Supported in part by Chem. Ind. Funds CFSTI: HC $3.00/MF $0.65

An attempt was made to determine the precise onset of equilibrium conditions during the heating of lithium cyanide and to study the reaction mechanism and the resulting intermediate products. The equilibrium $2\ LiCN \rightleftharpoons Li_2CN_2 + C$ was examined in the temperature range from 350° to 800 °C in argon and nitrogen without catalysts as well as with iron present as a catalyst. The

conditions under which the resulting carbon reacts with iron, molybdenum, and tungsten were studied, and the formation of carbides was observed. The activity of the carbon was changed during the reactions in order to obtain different carbides. Transl. by K.W.

N68-25927# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
DETERMINATION OF MICROGRAM QUANTITIES OF FLUORIDE IN METAL OXIDES
C. E. Plucinski Mar. 1968 12 p refs
(Contract AT(45-1)-1830)
(BNWL-601) CFSTI: HC $3.00/MF $0.65

A method for rapid and precise determination of fluoride in uranium and plutonium oxides was developed. The fluoride is separated from the oxide matrix by pyrohydrolysis and the amount measured with an electrode sensitive to fluoride ion activity. One to 100 ppM of fluoride can be determined in less than 15 min with a relative standard deviation of 3%. Author (NSA)

N68-25942 Brown Univ., Providence, R. I.
PARAMAGNETIC PEROXYBORATES: A MAGNETIC RESONANCE STUDY
David Lawrence Griscom (Ph.D. Thesis) 1966 184 p
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-2245

Electron spin resonance (ESR) and nuclear magnetic resonance (NMR) studies have been carried out on a number of specimens of effervescent peroxyborate (EPB) materials which exhibit large static susceptibilities. Specimens which had been thermally prepared from polycrystalline $NaBO_3 \cdot H_2O$ or $KBO_3 \cdot 1/2H_2O$ are seen to display three characteristic types of ESR spectra. One of these (denoted the X resonance) is found to contain of the order of 10^{21} spins per cubic centimeter and is characterized at room temperatures by a Lorentzian line centered at $g \approx 2.0$ with a linewidth of ≈2500 gauss. The identification of X-resonance center is shown to be an RO_2 configuration. A species designated as the Y resonance is demonstrated to arise from small concentrations of O_3^- ions, present interstitially. A theoretical treatment of the g tensor for O_3^- is carried out. The third ESR spectrum (referred to as the Z resonance) has been attributed to interstitial O_2^- ions which are coupled with their neighbors by a weak isotropic exchange interaction. Dissert. Abstr.

N68-25997 Michigan Univ., Ann Arbor.
PHYSICAL AND CHEMICAL EFFECTS OF DISPERSED SPINEL IN CHROMIUM IN THE PRESENCE OF NITROGEN
David Milton Scruggs (Ph.D. Thesis) 1966 110 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8342

This investigation is concerned with the interaction between nitrogen and spinel in a chromium matrix. The mechanical properties of chromium containing spinel were studied. The chemical relationships in the system chromium, spinel and nitrogen were examined. Experiments were performed to determine the extent of reaction between nitrogen and two different spinels, between chromium nitrides and magnesium aluminate spinel, and in a chromium-spinel system with varying amounts of nitrogen. The microstructures of the material under study were examined by light and electron microscopy and with an electron-beam microanalyzer. Mechanical properties of the chromium-spinel system confirm that nitrogen causes embrittlement in chromium and demonstrate ductile behavior that can only be explained by a very low level of nitrogen in the matrix. Chemical experiments demonstrate that both magnesium aluminate and magnesium chromite spinels are inert to nitrogen atmospheres to 1400°C. The hypothesis that spinel chemically renders the chromium matrix relatively free of nitrogen, and therefore ductile, was confirmed. Dissert. Abstr.

N68-26012 Cornell Univ., Ithaca, N. Y.
A STUDY OF A SHOCK TUBE MOLECULAR BEAM TIME-OF-FLIGHT MASS SPECTROMETER TECHNIQUE TO OBSERVE GAS PHASE CHEMICAL REACTIONS
Gerald Frederick Marsters (Ph.D. Thesis) 1967 134 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-9194

A shock tube has been coupled with a time-of-flight mass spectrometer for the purpose of studying fast chemical reactions in the gas phase. The coupling is accomplished by means of a free expansion from the open end of the shock tube into a dump tank system. The core portion of the efflux of shock heated gases is expanded and collimated forming a molecular beam. The expansion serves to freeze the chemical reactions and the molecular beam is injected into the ion source of the mass spectrometer. Details of experiments performed with this system are included, and data are presented for the unimolecular decomposition of C_4F_8. These data confirm the applicability of the method at least for the temperature range where the decomposition is known to be simply unimolecular. Problems in data recording and in molecular beam sampling are discussed. Dissert. Abstr.

N68-26027# Technische Hochschule Munchen (West Germany).
ON THE STRUCTURE OF ORGANIC SULPHUR COMPOUNDS [ZUR STRUKTUR VON ORGANOSCHWEFELVERBINDUNGEN]
Petr Simak (Ph.D. Thesis) [1968] 88 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

The effects of dipole moments and kinetics in organic sulfide, sulfur oxide, and sulfone reactions were studied with emphasis on the exchange reactions of S-atoms with neighboring π-electron systems of the benzothiacyclenone groups. Dipole calculations and spectrum analyses of benzothiacyclenone oxydation kinetics showed the highest conjugate transfer constants when the benzol ring was coplanar with the C_{aryl}-S-C_{alkyl} level and with the carbonyl group level. Transl. by G.G.

N68-26029# Technische Hochschule Munchen (West Germany).
PREPARATION AND REACTIONS OF 1-SUBSTITUTED 2.2.2-TRIFLUORO-N-ACYL ETHYLAMINE [DARSTELLUNG UND REAKTIONEN VON 1-SUBSTITUIERTEN 2.2.2-TRIFLUOR-N-ACYL-AETHYLAMINEN]
Alfred Maierhofer (Ph.D. Thesis) 1968 60 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Acid amides and urethane reacted with trifluoracetaldehyde and its derivatives to form 2.2.2.-trifluor-1-hydroxy-N-acyl-ethylamines; chlorination and acylation gave the corresponding 1-chlor- and 1-acyloxyde compounds. 2.2.2.-trifluor-1-hydroxy-N-acyl-ethylamine with acid-labile acyl radicals are only obtainable by acylation. All three compounds can be reacted with amines, thioles, and alkaliazides to give good yields in peptide synthesis by Woodward's method. Transl. by G.G.

N68-26030# Technische Hochschule Munchen (West Germany).
THE SIGNIFICANT PARAMETERS AFFECTING FILTRATION IN A DRUM FILTER AND THEIR FUNCTIONAL INTERRELATION [DIE WESENTLICHEN EINFLUSSGROESSEN FUER DIE FILTRATION AUF EINEM DREHFILTER UND IHR FUNKTIONELLER ZUSAMMENHANG]
Peter Thoma (Ph.D. Thesis) 1967 33 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

The relationships between the functional parameters of a rotating filter mechanism were studied theoretically by mathematical models and experimentally by comparing the filter cake thickness and filtrated volumes with those of a manual filtering plate; results agreed with ± 7%. It was established that the flow resistance of the filter cake depended on the grain parameters, the porosity, the grain mixtures used, and the long term flow effects on the filtering cloth. Transl. by G.G.

N68-26032# Technische Hochschule Munchen (West Germany).
PREPARATION AND REACTIONS OF 2,2,2-TRIFLUOR-1-ACYLAMINO-1-ALKYLSULFONYL-ETHANE COMPOUNDS [DARSTELLUNG UND REAKTIONEN VON 2.2.2-TRI-FLUOR-1-ACYLAMINO - 1 -ALKYLSULFONYL , AETHAN - VERBINDUNGEN]
Adolf Bauer (Ph.D. Thesis) 1968 57 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

By varying the acyl- and alkyl radicals of the sulfones in 2.2.2.-trifluor-1-alkysulfonyl-N-acyl-ethylamine it was possible to obtain: water solubility by introducing hydrophile groups in the alkyl-sulfonyl group, color by introducing azo groups into the acyl radical, and separation after reaction with amino acids and an acyl group of the urethane type. Transl. by G.G.

N68-26033# Technische Hochschule Munchen (West Germany). Oskar von Miller-Inst.
DETERMINATION OF THEORETICAL RUN-OFF LINES USING ELECTRONIC CALCULATION OF PRECIPITATION CONCENTRATION AND RETENTION (HYREUN PROCESS) [BESTIMMUNG THEORETISCHER ABFLUSSGANGLINIEN DURCH ELECTRONISCHE BERECHUNG VON NIEDER-SCHLAGSKONZENTRATION UND RETENTION (HYDREUN-VERFAHREN)]
Gert A. Schultz (Ph.D. Thesis) 1968 161 p refs In GERMAN
(Rept.-11) CFSTI: HC $3.00/MF $0.65

A hydrograph synthesization technique has been further developed and improved in order to apply it to catchment areas up to about 500 square miles. The extensive calculation work was performed by digital computer using an ALGOL-code program. For thirty observed floods more than 1,000 single synthetic hydrographs have been calculated, sixty of which were plotted in the paper. A dimensionless hydrological deviation expression developed and used to show that: (1) by introducing further parameters into the computations a significant reduction of the deviations could be achieved; and (2) the improved version of the HYREUN-method renders more accurate results than the conventional unit-hydrograph technique. It was furthermore possible to show that the accuracy of the HYREUN-method did not deteriorate with increasing catchment area. Author

N68-26034# Technische Hochschule Munchen (West Germany).
ORGANOMETALLIC COMPOUNDS OF TITANIUM(2) WITH CYCLOPENTADIENYL LIGANDS [METALLORGANISCHE VERBINDUNGEN DES TITAN(2) MIT CYCLOPENTADIENYL-LIGANDEN]
Rudolf Amtmann (Ph.D. Thesis) 1967 91 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Dicyclopentadienyltitanate was obtained through the reaction: $(C_5H_5)_2Ti(CH_3)_2 + H_2 \rightarrow$ "$(C_5H_5)_2Ti$" + CH_4 with a Ti(III) intermediary step. EPR spectra showed that the hydrogen interacted with the metal in such a way that one-nucleus molecules combined with another. Mass spectra analyses established the compound structure of dicyclopentadienyltitan as $Ti_2C_{20}H_{20}$ with a symmetrical cyclopentadienyl ring. A very solid metal-metal ligand was assumed between the two titanium atoms of the compound, each of which carried two π-bonded, but not parallel, cyclopentadienyl rings. Reaction of $Ti_2C_{20}H_{20}$ with a CO ligand gave dicyclopentadienyltitandicarbonyl; experimental substitution of the carbonyl with mono-and diphosphines, isonitril, mono- and diolefines showed a pronounced dependence on the π-acceptor character of the ligand. Reaction of $(C_5H_5)_2Ti(CO)_2$ with 2,2'-dipyridyl gave a black-blue crystalline compound that contained coordinated cyclopentadienyl- and dipridy ligands at the central metal atom. EPR and magnetic analysis of a deep green compound from the reaction $(C_5H_5)_2Ti(CO)_2$ with o-phenanthroline established the presence of a titanium(III) complex. Transl. by G.G.

N68-26036# Technische Hochschule Munchen (West Germany).
GAS CHROMATOGRAPHIC TESTS FOR RACEMIZATION-FREE PEPTIDE SYNTHESIS [GASCHROMATOGRAPHISCHE UNTERSUCHUNGEN ZUR RACEMISIERUNGSFREIEN PEP-TIDSYNTHESE]
Dieter Hoffman (Ph.D. Thesis) 1968 83 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Anhydrides and N-hydroxypiperidine-hydrochloride were used to synthesize the amino acid N-hydroxypiperidinester-hydrochlorides which in turn were changed into N-acyl-dipeptide-N-hydroxypiperidinester. Subsequent reaction with amino acid-alkylester-hydrochlorides and sodium acetate gave good yields of N-acyl-tripeptide-alkylester. This peptide synthesis avoids the formation of free dipeptide esters and results in a racemization-free synthesis of tripeptide derivatives. Several diastereomere trifluoracetyl-tripeptide-methylesters were separated by gas chromatographic columns. Transl. by G.G.

N68-26073 Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr (West Germany).
PHOTOCHEMISTRY, PART 1
Sep. 1967 220 p refs Intern. Conf. held at Munich, 6–8 Sep. 1967
(PB-176466)

Conference papers on photochemistry in gas phase and on free radical reactions are presented. For individual titles see N68-26074–N68-26102.

N68-26074* Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Chemistry.
ISOTOPIC ENRICHMENT OF NITROGEN IN THE PHOTOLYSIS OF NO
C. F. Schmidt, R. R. Reeves, Jr., and Paul Harteck *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 1–8 refs (See N68-26073 15-06) CSCL 07D
(Grant NsG-261)

Photolysis of NO in the vacuum ultraviolet yielded M_2, O_2, NO_2, and N_2O. When the photolysis was carried out using the 1633 A line of bromine, the N_2 initially formed was found to be enriched in nitrogen-15. The dependence of the enrichment on several parameters was studied, including temperature, pressure, the initial isotope ratio, and inert gases. The enrichment of the N_2 in $N^{15}N^{14}$ over $N_2{}^{20}$ produced in the photolysis was due to relatively more $N^{15}O$ being excited, and reacting before isotope scrambling occurred by energy transfer. Author

N68-26075 Oxford Univ. (England). Physical Chemistry Lab.
PHOTOLYSIS OF OZONE AT LOW PRESSURES
R. P. Wayne and I. F. White *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 9–19 refs (See N68-26073 15-06)

A technique has been developed for the determination of the quantum yield of ozone photolysis at low pressures. A continuous flow system was used, and the rate of ozone decomposition was calculated from changes in intensity of the chemiluminescent reaction between ozone and nitric oxide. Some preliminary determinations of relative quantum yields are presented, which appear to indicate that chain propagation processes are unimportant at pressures below about 0.5 mm. Hg. Author

N68-26076 Tokyo Inst. of Tech. (Japan). Lab. for Physical Chemistry.
PRESSURE EFFECTS IN THE PHOTOLYSIS OF CH_3CD_3 AT 1470 Å AND C_2H_6 AT 1577 Å
Hajime Akimoto and Ikuzo Tanaka *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 20–27 refs (See N68-26073 15-06)

The photolysis of CH_3CD_3 at 1470 Å and C_2H_6 at 1577 Å was studied to check the validity of previously reported reaction schemes describing the photolysis of CH_3CD_3 at 1470 and at 1236 Å, and the validity of previous data on intermediate excited states derived during studies of the pressure dependence of the formation ratio of ethylene to acetylene for the photolysis of C_2H_6. It is shown that at 1470 Å internal scavenging of hydrogen atoms produced in the reaction $C_2H_6 + 2H + C_2H_4$ occurs at room temperature so that the ethylene to acetylene ratio decreases as a function of conversion. On the other hand, no scavenging should occur at 310°C as postulated by previous investigators. It was found that the ratio of ethylene to acetylene was dependent on ethane pressure. Also studied was how the isotopic distribution in ethylene in the photolysis of CH_3CD_3 changes with pressure. Yields of C_2H_3D, $C_2H_2D_2$, and C_2HD_3 as a function of pressure were studied. The yield calculations were based upon the isotopic distribution of ethylene and the primary formation ratio of ethylene to acetylene, and were normalized so that the total primary yield of ethylene and acetylene was unity. Values obtained are summarized, and it is shown that the proposed method can be used to analyze similar curves representing the pressure dependence of the formation ratio of ethylene to acetylene in the photolysis of ethane. S.C.W.

N68-26077 Ecole Superieure de Physique et de Chimie Industrielles, Paris (France).

METHANOL PHOTOCHEMISTRY: COLLISION INDUCED-PREDISSOCIATION

J. Hagege, P. C. Roberge, and C. Vermeil *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 28–41 refs (See N68-26073 15-06)

In an attempt to explain the photochemical behavior of methanol under irradiation by the continuum emitted by a hydrogen discharge lamp, the efficiency of a foreign gas in increasing the photodissociation of methanol was studied at the 1850 Å wavelength. Analyzed is the hypothesis of an induced predissociation. It is speculated that if the hypothesis as an explanation to the pressure effect in the methanol photochemistry is correct, the transition from the first Rydberg state to the dissociative state is either symmetry-forbidden, either spin-forbidden, or both at the same time. Results support the idea of collision induced predissociation. It is concluded that: (1) the transition has to be symmetry forbidden as suggested by the role of light molecules in promoting it and by the applicability of Steinfeld's model; (2) in using Steinfeld's model, a degeneracy requirement must be considered; (3) there is an additional spin-forbidden aspect to be considered since the fact that the spin orbit contribution is purely additive most likely indicates that it opens up additional disociation channels. S.C.W.

N68-26078 Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr (West Germany).

THE RARE GAS PHOTOSENSITIZED EXCHANGE REACTION BETWEEN HYDROGEN AND DEUTERIUM

Guenther von Buenau and Ralph N. Schindler *In its* Photochem., Pt. 1 Sep. 1967 p 42–57 refs (See N68-26073 15-06)

Experiments on rare gas (xenon and krypton) photosensitized atom exchange between hydrogen and deuterium are reported. Microwave powered lamps equipped with LiF windows and filled with about 1 torr xenon or krypton were used for irradiation at 1470 Å and 1235 Å with 1165 Å respectively. The xenon lamp was cooled with liquid oxygen, the krypton lamp with liquid nitrogen to assure chromatic purity of the emitted radiation. During krypton sensitized exchange studies it was found that traces of mercury vapor could be excited by the krypton line and lead to some mercury photosensitized reaction. During irradiations, therefore, mercury was kept frozen out by cooling part of the reaction vessel to −196°C. Blank runs showed no significant contribution from mercury photosensitization under these circumstances. By keeping part of the reaction vessel at −196°C a constant partial pressure of 2.1 torr krypton was maintained in all runs. The partial pressure of the H_2–D_2 mixture varied between about 0.5 and 10 torr. HD-formation was found to depend on the H_2–D_2 pressure. As in the case of the krypton sensitized reaction mercury was excluded in the xenon sensitized experiments. Neither at −196° nor at −183° was the vapor pressure of xenon high enough to assure total absorption. It was found however, that some xenon sensitization takes place when a H_2–D_2–Xe mixture is irradiated with the krypton lamp. Experiments provided strong evidence that excited krypton and xenon can efficiently transfer energy to hydrogen molecules and induce their dissociation into ground state atoms. S.C.W.

N68-26079 Max-Planck-Institut fuer Spektroskopie, Gottingen (West Germany).

TRANSFER OF VIBRATIONAL ENERGY IN EXCITED ELECTRONIC STATES

M. Stockburger *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 58–64 refs (See N68-26073 15-06)

In fluid and rigid media the nuclear vibrational energy of polyatomic molecules relaxes much more rapidly than the electronic energy of their lowest singlet or triplet state. In these media the fluorescence or phosphorescence spectra yield no information on the relaxation processes. In view of the limited data on relaxation processes of polyatomic molecules, the spectra in the vapor phase were studied and information from their vibrational structure was obtained. Studied were two fundamentally different relaxation processes: (1) intermolecular transfer of vibrational energy; and (2) internal conversion of vibrational energy. Reported are results of studies of the fluorescence spectra of napthalene vapor after excitation by the mercury line 2537 Å; and studies of the discharge spectra of benzene, toluene, naphthalene, and phenanthrene. S.C.W.

N68-26080 Northwestern Univ., Evanston, Ill. Dept. of Chemistry.

VIBRATIONAL ENERGY TRANSFER IN INELASTIC COLLISIONS OF VIBRONIC STATES

H. von Weyssenhoff, E. W. Schlag, and M. Starzak *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 65–67 refs (See N68-26073 15-06)

Discussed is a simple three level model for calculating vibrational energy transferred in an inelastic collision with an inert gas molecule. Theoretical implications of the model are also discussed. S.C.W.

N68-26081 Northwestern Univ., Evanston, Ill. Dept. of Chemistry.

DIRECT MEASUREMENT OF RATE CONSTANTS FOR PHOTOEXCITED MOLECULES

E. W. Schlag, H. von Weyssenhoff, and M. E. Starzak *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 68–72 refs (See N68-26073 15-06)

A method for the direct measurement of gas rate constants for photoexcited molecules is described. The proposed method focuses on the use of a phase fluorimeter which measures the phase lag of a fluorescent signal relative to the incident signal produced by an intensity modulated light beam. Of particular interest are measurements at low gas pressures (collisionless region) with light from a monochromator to allow scanning. The applicability of the method in the kinetic treatment of data for experiments on β-naphthylamine is analyzed. S.C.W.

N68-26082 Kyoto Univ. (Japan). Inst. for Chemical Research.
DETERMINATION OF THE RATE CONSTANT OF FAST REACTION FROM THE TRANSIENT CONCENTRATION PROFILE BY MEANS OF A TIME-OF-FLIGHT MASS SPECTROMETER
Yoshimasa Takezaki and Sadayuki Mori *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 73–90 refs (See N68-26073 15-06)

To overcome inherent problems associated with the use of a mass spectrometer in flow system and stirred tank reactor techniques in kinetic studies of free radical reaction an alternative procedure was developed that is applicable to analyses of very fast reactions. The procedure was developed to estimate the effective volume which may be tentatively usable in the analysis and is based on the measurement of transient change of the concentration of radicals in the effluent gas from a micro-reactor using a time of flight mass spectrometer. To demonstrate the capability of the proposed method, the fast reaction $O + NO_2 \rightarrow O_2 + NO$ is analyzed. It is concluded that although the obtained result is by no means satisfactory for precise determinations since further refinements are needed, this procedure is expected to be useful as a method for the determination of very fast reaction rate constants. S.C.W.

N68-26083 Bonn Univ. (West Germany).
THE CHEMILUMINESCENT REACTION NO + O + (M) → NO_2^* + (M)
H. H. Becker, W. Groth, and F. Joo *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 91–93 refs (See N68-26073 15-06)

As part of a preliminary investigation on the kinetic behaviour of various chemiluminescent reactions below 10^{-2} torr, the NO + O + (M) → NO_2^* + (M) reaction was restudied. In preliminary experiments in a 200 l glass sphere the NO_2^* light intensity was measured as a function of the total pressure between 2×10^{-3} and 2.5×10^{-2} torr for several added gases, including Ar, O_2, and SF_6. Results showed that the reaction follows a three body mechanism below 2.5×10^{-2} torr, and that it is in this pressure region where the chemiluminescence is changing from a pressure dependent to a pressure independent reaction due to the quenching of NO_2^*. Measured quenching constants (k_2/K) were: 40 to 80 $torr^{-1}$ for Ar, 60 to 100 $torr^{-1}$ for O_2, and 150 to 200 $torr^{-1}$ for SF_6. These values were in good agreement with the quenching constants reported in previous fluorescence measurements. It was further found that the nature of M has no influence on the apparent two body rate constant $k_1(k_2/K)$, so that k_1 would have the same dependence on the nature of M as the quenching rate constant k. It is surmised that this behaviour of the oxygen atom concentration would explain the results of previous investigations in which it was deduced that there was no effect of total pressure on the NO_2 emission. S.C.W.

N68-26084* Geophysics Corp. of America, Bedford, Mass.
REACTIONS OF D^1 OXYGEN ATOMS. 4: REACTIONS WITH N_2O, N_2 AND CO_2
Peter Warneck and J. O. Sullivan *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 94–112 refs Sponsored by NASA (See N68-26073 15-06) CSCL 07D

Ozone quantum yields from mixtures of oxygen with N_2O, N_2 and CO_2, photolyzed at 1470 Å are investigated to determine relative rates of reaction of ^1D oxygen atoms with the admixed gases. The data are expressed with respect to the rate of reaction with CO_2 for comparison with similar data obtained by Cvetanović from the photolyses of N_2O and NO_2. Order of magnitude agreement is observed. Author

N68-26085 National Center for Atmospheric Research, Boulder, Colo.
PHOTOCHEMISTRY OF THE SYSTEM KETENE–NO–H_2
R. D. Cadle and F. E. Grahek *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 113–125 refs (See N68-26073 15-06)

Nitric oxide has been found to react rapidly with singlet methylene produced by the photolysis of ketene and possibly also with excited ketene, judging from the ratios ethylene produced/ketene reacted. The presence of nitric oxide prevented the formation of methane and ethane when ketene–NO–H_2 mixtures were irradiated at room temperature or 200°C. The products resulting from the presence of nitric oxide were all of low molecular weight, judging from the mass spectra. Eight products were separated using gas chromatography and their mass and infrared spectra determined. Only one, hydrogen cyanide, was definitely identified. Author

N68-26086 National Bureau of Standards, Washington, D. C.
PHOTODISSOCIATION OF NOCl AND NO_2 IN THE VACUUM ULTRAVIOLET
M. Lenzi and H. Okabe *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 126–148 refs Sponsored in part by AEC (See N68-26073 15-06)

The photodissociation of NOCl and NO_2 in the vacuum ultraviolet yields the electronically excited NO molecule which fluoresces in the near ultraviolet. The fluorescence spectrum, which lies mostly in the region 2200 to 4000 Å, extends below 2200 → as the wavelength of incident light decreases. This is interpreted in terms of the production of the NO $C\,^2\Pi$, $D\,^2\Sigma^+$, $B'\,^2\Delta$, $E\,^2\Sigma^+$ along with the production of the NO $A\,^2\Sigma^+$, $B\,^2\Pi$. The fluorescence intensity and the yield were measured as a function of incident wavelength, and fluorescence curves thus obtained were correlated with the absorption spectrum. The absorption coefficient of NOCl in the region 1100 to 2200 Å was measured. It was found that: (1) the absorption spectrum of NOCl between 1100 and 1700 Å may be divided into three regions, respectively, corresponding to transitions providing the NO $A\,^2\Sigma^+$, (NO $C\,^2\Pi$, $D\,^2\Sigma^+$) and (NO $B'\,^2\Delta$, $E\,^2\Sigma^+$) with a simultaneous production of the ground state NO or other products, (2) the absorption by NO_2 in the spectral region from 1100 to 1450 Å involves transitions yielding the NO $A\,^2\Sigma^+$, $B\,^2\Pi$, NOC $^2\Pi$, $D\,^2\Sigma$ and NO $B'\,^2\Delta$, $E\,^2\Sigma^+$ below their respective threshold wavelengths of incident light, (3) threshold energy of the incident photon producing the NO $A\,^2\Sigma^+$, $B\,^2\Pi$ gives an upper limit of bond dissociation energy, and (4) the bond energies obtained are D(NO–Cl) $\leq$ 1.77 $\pm$ 0.05 eV and D(NO–O) $\leq$ 3.22 $\pm$ 0.05 eV which are 0.17 eV and 0.10 eV higher than the respective values obtained from the heat formation. Author

N68-26087 Brussels Univ. (Belgium).
ACTIVATED MONOCHLOROETHYL RADICALS IN THE PHOTOCHLORINATION OF ETHYLENE
J. A. Franklin, P. Goldfinger, and G. Huybrechts *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 149–165 refs (See N68-26073 15-06)

The competitive photochlorination of ethylene and ethane has been studied at 310°K in the absence and presence of added SF_6 and CO_2. The results are interpreted by a mechanism involving the monomolecular dissociation and the collisional deactivation of activated chloroethyl radicals formed in the reaction. The dissociative life-time of $C_2H_4Cl^*$ is estimated and the deactivation of this radical by various molecules is discussed. Author

N68-26088 National Research Council of Canada, Ottawa (Ontario). Div. of Applied Chemistry.
THE PHOTOOXIDATION OF BUTENE-1 BY NITROGEN DIOXIDE AT SHORT WAVELENGTHS
K. F. Preston and R. J. Cvetanovic *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 166–192 refs (See N68-26073 15-06)
(NRC-0000)

The photooxidation of butene-1 by nitrogen dioxide has been studied at 2288 Å and at longer wavelengths. From the measured effects of additions of inert and other gases on the product yields it is concluded that $^1D_2$ oxygen atoms participate in the photooxidation at 2288 Å. Ground state oxygen atoms, produced by the photodissociation of NO_2 and possibly by quenching of $O(^1D)$ by the olefin, are also important in the photooxidation at 2288 Å, and are believed to give rise to practically all of the observed yields of the addition products, n-butanal and 1,2 epoxybutane. The indications are that the reaction of $O(^1D)$ with butene-1 at total pressures below one atmosphere yields very little stabilized addition product. Author

N68-26089 University Coll. of North Staffordshire, Keele (England). Dept. of Chemistry.
THE UNSENSITISED PHOTOLYSIS OF BUT-1-ENE AT 1849 Å
Peter Borrell and P. Cashmore *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 193–210 refs (See N68-26073 15-06)

On photolysis at 1849 Å but-1-ene yields 25 hydrocarbon products and a solid polymer. In order to ellucidate the mechanism the effects of added gases, time, pressure of reactant gas and temperature were investigated. A free radical mechanism is postulated in which there are six primary reactions to account for the products and their relative yields. The two major primary reactions are cleavage of the C–C and C–H bonds in the β position to the double bond in a 6:1 ratio. Addition of foreign gases to the system caused a decrease in the product yield which was shown to be due to quenching of the reaction. This is attributed to the collisional deactivation of an excited state intermediate of which the decomposition lifetime has been estimated to lie within the values of 2.6 to 6.4 $\times 10^{-10}$ sec. Author

N68-26090 Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr (West Germany).
PRIMARY MODES OF DECOMPOSITION OF SUPEREXCITED N-ALKANE MOLECULES
P. Ausloos and S. G. Lias *In its* Photochem., Pt. 1 Sep. 1967 p 211–241 refs (See N68-26073 15-06)

This investigation is intended to serve as an illustration that the modes of decomposition of hydrocarbon molecules excited to states above their ionization energies can be studied provided that all ionic processes occurring in the system can be accounted for. This provision, it is shown, can be fulfilled using isotopic labelling of the irradiated molecules and the use of data from mass spectrometry and radiation chemical investigations. Results indicate that: (1) an alkane molecule in an excited state of energy higher than the ionization energy does not exhibit any new or unusual behavior; that is, the modes of decomposition observed showed that these superexcitation energies are the same as those observed at excitation energies below the ionization energy; and (2) the differences in relative importance of the various processes as compared to the lower energy photolyses are those which would be predicted for dissociation from a higher energy state. S.C.W.

N68-26091 Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr (West Germany).
TWO PROBLEMS IN THE GAS PHASE PHOTOLYSIS OF ACETONE
P. Potzinger and G. von Buenau *In its* Photochem., Pt. 1 Sep. 1967 p 242–247 refs (See N68-26073 15-06)

Photolyses of acetone vapor were performed, and resulting full product analyses as a function of wavelength, temperature, and additives were studied in an attempt to answer the following questions: (1) If the primary quantum yield of acetone decomposition is equal to one above 100 (which is the basis of acetone actinometry), is it less than unity below that temperature? (2) Why has hydrogen been detected as a product of acetone photolysis only in the far ultraviolet, although from an energetic point of view it should be expected already at wavelengths below 280 nm. Quantum yields of all significant products from acetone pholysis at 254 and 185 nm at room temperature are tabulated. It was found that the primary quantum yield of acetone decomposition becomes less, if the acetone is excited at 185 nm. In this spectral region pronounced structure of the absorption band prevails. From a molecular orbital viewpoint, this band should be assigned to an $n-6^*$ configuration of the excited acetone. Decomposition of this state can only occur via predissociation. It was further found that using unimolecular rate theory at 185 nm the process $CH_3COCH_3 \rightarrow H + CH_2COCH_3$ cannot occur by vibrational predissociation; instead, transition to another electronic state must be made. The above cited chemical process is also possible at 254 nm although only at a very low quantum yield; however, here again transition to another electronic state must occur. S.C.W.

N68-26092 Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Chemistry.
THE GAS PHASE PHOTOLYSIS OF HEXAFLUOROACETONE IN THE PRESENCE OF DIBORANE
Robert L. Strong, William M. Howard, and Robert L. Tinklepaugh *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 248–266 refs (See N68-26073 15-06)
(Grant NSF G-19931)

The photolysis of hexafluoroacetone with 3130 Å light in the presence of diborane has been investigated. Major products are CO, H_2, CF_3H, and C_2F_6, but all of the fluoroform is produced by secondary H-atom abstraction from products of the photolysis, possibly an addition product formed at the walls between CF_3 and BH_2. A reaction mechanism is presented involving deactivation of the excited singlet and triplet states of the hexafluoroacetone molecule with simultaneous photosensitized diborane dissociation as the primary source of molecular hydrogen. Author

N68-26093 Edinburgh Univ. (Scotland). Chemistry Dept.
THE PHOTOLYSIS OF CYCLOPROPANE CARBOXALDEHYDE
G. Greig and J. C. J. Thynne *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 267–282 refs (See N68-26073 15-06)

The vapor phase photolysis of cyclopropane carboxaldehyde has been studied at various pressures over the temperature range 40°–250°C. A major primary process is the intramolecular reaction yielding propylene and carbon monoxide. Cyclopropyl radicals are also produced and have been shown to isomerise to allyl radicals with an estimated activation energy of 22 kcal. mole^{-1}. A value of 2 has been obtained for the crosscombination ratio for allyl and cyclopropyl radicals. Cyclopropanacarbonyl chloride has been photolysed alone and in the presence of methane. Cyclopropyl radicals are produced and bicyclopropyl, cyclopropyl chloride, methyl chloride and methyl cyclopropane have been identified as reaction products. Author

N68-26094 Edinburgh Univ. (Scotland). Chemistry Dept.
THE PHOTOLYSIS OF ORGANIC ESTERS
M. J. Yee Guee and J. C. J. Thynne *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 283–303 refs (See N68-26073 15-06)

The vapor phase photolysis of methyl formate and dimethyl carbonate was studied in the temperature range 30°C to 103°C. After photolysis methoxyl, methyl, and formyl radicals were generated. Rate constants were deduced for several reactions. Contrary to previous reports dimethyl carbonate was observed to undergo extensive photodecomposition generating methyl and methoxyl radicals. Arrhenius parameters were also measured for several reactions. Results indicated that although the photolyses of methyl formate and dimethyl carbonate provides a ready source of methoxyl radicals, the decomposition is complicated by the

simultaneous generation of other radical species so that elucidation of the individual reactions is difficult. At temperatures below 100°C however, radical–radical reactions are more significant than radical–molecule reactions. This finding was used to derive rate constants for reactions involving methyl, methoxyl, and formyl radicals. S.C.W.

N68-26095 Hunter Coll., New York. Chemistry Dept.
THE REACTIONS OF HYDROGEN ATOMS WITH VINYL CHLORIDE
A. M. Rennert and M. H. J. Wijnen *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 304–319 refs Sponsored in part by NSF (See N68-26073 15-06)

The photolysis of HI in the presence of C_2H_3Cl was carried out at room temperature, at various HI/C_2H_3Cl ratios, at different light intensities, and as a function of total pressure. As a scavenger for H atoms, HI was six times more effective than C_2H_3Cl. Quantitative data concerning the relative reactivity of vinyl radicals with HI and C_2H_3Cl were also obtained. Author

N68-26096 National Center for Atmospheric Research, Boulder, Colo.
THE REACTIONS OF METHYL AND ACETYL RADICALS WITH THE OXIDES OF NITROGEN
Eric R. Allen and Kent W. Bagley *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 320–329 refs (See N68-26073 15-06)

The reactions of methyl and acetyl radicals with the oxides of nitrogen have been investigated by photolyzing either acetone or biacetyl in the presence of nitric oxide, or nitrogen dioxide in the presence of acetaldehyde. A most important reaction in all these studies was found to be addition with nitrogen dioxide to form nitromethane: $CH_3 + NO_2 \rightarrow CH_3NO_2$. The metathetical reaction: $CH_3 + NO_2 \rightarrow CH_3O + NO$ was found to be measurable but of lesser importance. Addition of nitrogen dioxide to methyl radicals to produce methyl nitrite: $CH_3 + NO_2 \rightarrow CH_3ONO$ occurred to a negligible extent if at all under the conditions of our experiments. It appears that if nitrosomethane is formed by the addition reaction with nitric oxide: $CH_3 + NO + (M) \rightarrow CH_3NO + (M)$ then it is mainly removed by reaction with excess nitric oxide or the displacement reaction with nitrogen dioxide: $CH_3NO + NO_2 \rightarrow CH_3NO_2 + NO$ at appreciable nitrogen dioxide concentrations. Author

N68-26097 Sheffield Univ. (England). Dept. of Chemistry.
SOME REACTIONS OF PARTLY-FLUORINATED ETHYL RADICALS
P. M. Scott and K. R. Jennings *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 330–342 refs (See N68-26073 15-06)

A study has been made of the mercury photosensitized decomposition of CH_3CH_2F and CH_3CHF_2 in which the primary process in each case is the cleavage of a C–H bond to produce a fluoro-alkyl radical. In the case of CH_3CH_2F, the primary process leads exclusively to the formation of the $CH_3CHF\cdot$ radical, and the hydrogen atoms formed in this process largely abstract a fluorine atom to produce $C_2H_5\cdot$ radicals. Subsequent reactions of these radicals lead to the observed C_2 and C_4 products. In the case of CH_3CHF_2 the primary process leads predominantly to the formation of the CH_3CF_2 radical, although some $CF_2H\cdot CH_2\cdot$ radicals are also formed. Fluorine abstraction by the hydrogen atoms formed in the primary processes lead to CH_3CHF radicals and subsequent reactions of the three fluoroalkyl radicals lead to a large number of products. Author

N68-26098 California Univ., Irvine. Dept. of Chemistry.
THE REACTIONS OF METHYLENE-T WITH ETHYLENE[1]
F. S. Rowland, Charles Mc Knight, and E. K. C. Lee *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 343–358 refs (See N68-26073 15-06)

Methylene has been shown in several series of experiments to react in the gas phase with ethylene to form both cyclopropane and propylene in amounts variable with the pressure of the system. It was found that when attempting to derive quantitative mechanistic explanations of results on both the methylene reactions, and on the isomerization of cyclopropane to propylene, inconsistencies arose since several areas of uncertainty existed. It is shown that these inconsistencies can be satisfactorily clarified using tritium-labeled methylene, CHT. A discussion of the advantages of using tritiated ketene, CHT=CO, with the formation of CHT by direct photolysis is presented which illustrates the applicability of radioactive tracers in such experiments. The reactions of CHT with ethylene were studied over the pressure range from 1 to 3000 cm Hg, and the following two parameters were measured for each experiment: (1) f_Δ, the yield of cyclopropane-*t* relative to the sum of cyclopropane-*t* and propylene-*t*; and (2) f_a, the fraction of propylene-*t* with tritium in the alkyl position. Two series of experiments were performed, one in the presence of molecular oxygen as a scavenger, and the other in its absence. The value of the two parameters, f_a and f_Δ, are tabulated. Included is a discussion of pressure dependence of cyclopropane-*t* yield, implications of methylene experiments, and the feasibility of using the proposed method for additional investigations. S.C.W.

N68-26099 California Univ., Davis. Dept. of Chemistry.
PHOTOCHEMISTRY OF ALLYL CHLORIDE IN LIQUID AND SOLID STATE
P. H. Volman and R. W. Phillips *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 359–367 refs (See N68-26073 15-06)

Reported are results of a post irradiation study using a microphotochemistry technique which was designed to determine if previous electron spin resonance studies on allyl chloride correctly predicted the formation of hydrogen chloride and allene. For room temperature photolysis of degassed pure allyl chloride, the main products appeared to be solely allene and propylene. Trace amounts of CH_4, C_2H_6, and C_2H_4 were also detected. HCl did not appear to be produced and no methylacetylene could be detected. For 77°K photolysis, nondegassed distilled allyl chloride was used. The main products consisted of allene, propylene, and cyclopropane. No methylacetylene could be detected. The formation of methane was in accord with results reported by previous investigators. Although cyclopropane was found in the products of photolysis of solid allyl chloride at 77°K it was not found in the products of photolysis of the liquid at room temperature. The absence of HCl in the liquid photolysis products and near equivalence of allene and propene indicated that the process may be wholly a cleavage of the carbon chlorine bond mechanism; however, molecular elimination of HCl is not excluded as it is possible that HCl is consumed by chemical reactions. S.C.W.

N68-26100 Queens Univ., Kingston (Ontario). Dept. of Chemistry.
ELECTRON SPIN RESONANCE STUDIES OF SOME NITROGEN RADICALS IN PHOTOLYTIC AND RADIOLYTIC SYSTEMS
J. K. S. Wan *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 368–381 refs Sponsored in part by Res. Corp., N. Y. and Natl. Res. Council of Can. (See N68-26073 15-06)

Electron spin resonance (ESR) studies of a few stable nitrogen radicals prepared by the reaction of photolytically produced hydrocarbon radical with azobenzene molecules, or by γ-irradiation of some solid ammonium compounds are reported. In the cumene-azobenzene systems, UV-irradiation leads to formation of

nitrogen radicals with structure similar to that of 2,2-diphenyl-l-picrylhydrazyl. Various substitutions on the azobenzene molecule changed the rates of radical formation and the ESR spectra. In the γ-irradiation system of the polycrystalline NH_4PF_6 NH_3+ and N_2H_4+ radicals were produced and stabilized in the crystal lattice. With Me_4NPF_6, the corresponding Me_3N+ and N_2Me_4+ were observed. A review is made on the existing evidence of an ammonium radical NH_4. Author

N68-26101 Bell Telephone Labs., Inc., Murray Hill, N. J.
PHOTODISSOCIATION OF MOLECULAR IODINE
E. Wasserman, W. E. Falconer, and W. A. Yager *In* Max-Planck-Inst. fuer Kohlenforschung Photochem., Pt. 1 Sep. 1967 p 382-399 refs (See N68-26073 15-06)

Electron spin resonance has been used to monitor iodine atom concentrations as functions of iodine pressure, light intensity, and magnetic field strength during in situ irradiation in the banded region and the continuum of $I_2B(^3\Pi O_u+)$. Evidence for direct predissociation as a major deexcitation process for $I_2(B)$ exists in the parallelism of $[I.]$ vs $[I_2]$ curves in the two regions of photoexcitation. The steady-state iodine atom concentration varies with the square root of incident light intensity; its dependence on molecular iodine concentration is complex. Author

N68-26102 Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr (West Germany).
KINETICS OF THE REACTION OF IODOBENZENE AND HYDROGEN IODIDE: THE HEAT OF FORMATION OF THE PHENYL RADICAL AND ITS IMPLICATIONS ON THE REACTIVITY OF BENZENE
Alan S. Rodgers, David M. Golden, and Sidney W. Benson *In its* Photochem., Pt. 1 Sep. 1967 p 400-423 refs (See N68-26073 15-06)
(Grant PHS-AP-00353-03)

The kinetics of the reaction of iodobenzene and hydrogen iodide were studied in the gas phase from 375°C to 500°C. The rate data were consistent with the following free radical mechanisms. A mechanism for abstraction from benzene is proposed and illustrated for the thermal chlorination and bromination of substituted benzenes. It is shown to be in quantitative and qualitative agreement with the available data. Author

N68-26108 Cornell Univ., Ithaca, N. Y.
F-CENTER FORMATION BY UV IRRADIATION IN SEVERAL MIXED AND PURE ALKALI HALIDES, AND A STUDY OF THE ICI V_K CENTER IN KCl(I)
Lawrence Spencer Goldberg (Ph.D. Thesis) 1966 160 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-1387

The process of F-center formation by exciton uv irradiation has been studied in KCl(I), KBr(I), KI, and RbI. A selected number of experiments were carried out in the pure alkali iodides, KI and RbI, and the results show striking similarities with those obtained for KCl(I), indicating that the mechanism of defect formation in the mixed and pure crystal systems is closely analogous. This mechanism is considered to be a thermally activated decomposition of a relaxed excited state configuration of the I^- ion, resulting in an intrinsic introduction of vacancy-interstitial pairs into the lattice, as evidenced by F and V-center growth. In KCl(I), the excitation spectrum for the strongly temperature dependent F-coloration process is a relatively narrow band region in the low energy side of the I^- absorption band. Two types of prominent V band growth are observed. In KI and RbI, the F-coloration process is also strongly temperature dependent. The penetration depth of the coloration is confined to a region near the irradiated surface. Analogous V band structure is observed. In the course of these experiments a new trapped hole center—the ICl-V_K-center—has been produced and identified in KCl(I) and KCl(I,Pb) crystals. Dissert. Abstr.

N68-26110 Michigan Univ., Ann Arbor.
HYDROSTATIC PRESSURE EFFECTS ON THE EPR SPECTRA OF DOPED SAPPHIRES
John Edward Herman (Ph.D. Thesis) 1966 172 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-8273

The interaction of the isoelectronic impurity ions V^{2+}, Cr^{3+}, and Mn^{4+} with the α-Al_2O_3 crystal lattice was studied by observing the hydrostatic pressure dependence of their electron paramagnetic resonance (EPR) spectra of 6000 atmospheres. A two sample comparison method was used in which two identical samples are placed in the X band microwave resonant cavity. One end of the cavity and one sample are subject to hydrostatic pressure. The changes in the spin Hamiltonian parameters are obtained by measuring the difference in the magnetic field required for the same resonance condition in each sample as a function of pressure. From the results, it is concluded that the ions occupy similar lattice sites and are subject to nearly the same compressibility. Comparison with both the crystal field model and the molecular orbital model revealed the predictions of both models for the pressure dependence were consistent. Dissert. Abstr.

N68-26115# National Bureau of Standards, Washington, D. C.
SEPARATION AND PURIFICATION SECTION. SUMMARY OF INITIAL ACTIVITIES, FEBRUARY 1966 THROUGH JUNE 1967
David H. Freeman, ed. Feb. 1968 42 p refs
(NBS-TN-429) GPO: HC $0.35; CFSTI: MF $0.65

A research capability for the study and refined adaptation of ion exchange materials is described. Activities are reported for the areas of extreme purification, chemical reagents, organic chemicals, including the use of crystallization for the achievement, protection, and measurement of chemical purity. Specific studies have been conducted in the purification of mineral acids, nitrobenzene, and the development of zone refining methods. Author

N68-26161 California Univ., Berkeley.
ELECTRON TRANSFER IN WEAKLY IONIZED GASES
Eric Keith Parks (Ph.D. Thesis) 1966 100 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8622

The recombination rate of positive and negative ions formed from the photoionization of thallium halide vapor is studied at various pressures of xenon and argon from 35 to 400 torr. The thallium iodide experiments are also done with the addition of nitrogen dioxide at a pressure of 70μ. The temperature of the vapor ranges from 260°C to 340°C. Experimental recombination coefficients and diffusion constants are obtained by fitting the recombination-diffusion loss curve to a numerical integration of the loss equations, using a computer. Using a radio frequency mass spectrometer a study is made of ions formed when thallium iodide is photolyzed with the 2062 Å light of an iodine lamp, and of the complexes that are subsequently formed. It is found that the addition of NO_2 converts I^- to NO_3 and not to the expected NO_2. The recombination coefficient in the zero pressure limit is found to be independent of the inert gas and ranged from 4.0 to 5.8×10^{-8} cm^3 sec^{-1}. Xenon is in all cases found more effective in increasing the three body recombination rate than argon. Author

N68-26169 Iowa State Univ. of Science and Technology, Ames.
THE DIFFERENTIAL CAPACITY OF THE ELECTRICAL DOUBLE LAYER AT THE SILVER IODIDE-AQUEOUS SOLUTION INTERFACE
David Morton Barshatky (Ph.D. Thesis) 1967 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8901

An impedance bridge was used to determine the equivalent series capacitance C_V and resistance R_V for the silver iodide aqueous solution system. An AgI electrode in contact with an aqueous potassium nitrate solution containing a very dilute concentration of Ag^+ and I^- ions served as the system. A cell potential range of about 420 millivolts was used at KNO_3 concentrations of .1N, .01N, and .001N. The C_V and R_V values at a given potential and electrolyte concentration were determined in a frequency range from 256 cycles per second to 9,168 cycles per second. Several electrodes of varying AgI thickness were studied to check the consistency of the results. An electrical analog circuit was proposed for the interface which was consistent with known properties of this interface and which adequately represented the dependence of C_V and R_V on frequency and potential over the ranges of frequency and potential studied. Dissert. Abstr.

N68-26176# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
DESCRIPTION OF LOW-ANGLE X-RAY SCATTERING OF THORIUM COLLOIDAL OXIDE [CARATTERIZZAZIONE PER DIFFRAZIONE DEI RAGGI X A BASSO ANGOLO DI OSSIDO DI TORIO COLLOIDALE]
A. Cabrini, G. Celotti, and R. Zannetti 1968 43 p refs In ITALIAN; ENGLISH summary
(TR/MET(68)1) CFSTI: HC $3.00/MF $0.65

Low angle X-ray scattering is used to study colloidal solutions and the sol-gel processes. The theoretical background of this method is described, and the feasibility of obtaining the shape, the mean particle size, and the specific surface of gels is discussed. The method is applied to correlate these characteristics with the system for the preparation of sols and to draw conclusions regarding the structure of gels. The results of electron microscope measurements are also reported. K.W.

N68-26181 California Univ., Berkeley.
KINETICS OF FORMATION OF XENON FLUORIDES
Clayton Fred Weaver (Ph.D. Thesis) 1966 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8667

The temperature dependence of the near ultraviolet region of the absorption spectra of F_2 and XeF_2 was determined to 400°C in fluorinated nickel cells with calcium fluoride windows. That of XeF_4 was determined to 250°C. This spectral information was used to study the kinetics of the formation of XeF_2 and XeF_4 in the same temperature regions and in the same nickel cells. Experimental conditions were chosen to cause the reactions to terminate at XeF_2 or XeF_4 as desired. In all cases studied the reaction rates were independent of the concentration of inert gas which was argon but were reduced by an increased volume to surface ratio. Hence the reactions were heterogeneous, even though they were very reproducible. The activation energies were uniformly low ranging from 12.8 to 15.7 kcal./mole. A mechanism involving adsorption and dissociation of F_2 on the NiF_2 surface is proposed. Dissert. Abstr.

N68-26183 California Univ., Berkeley.
THE REVERSIBILITY OF THE REACTION OF ALKALI METALS WITH LIQUID AMMONIA
Ernest James Kirschke (Ph.D. Thesis) 1966 71 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-8589

Ammoniated electrons exist in solutions of the alkali metal amides in liquid ammonia which have reached thermodynamic equilibrium with hydrogen gas. By using both electron paramagnetic resonance and optical spectroscopy to measure the electron concentration an equilibrium constant of 5×10^{-4} was measured for the reaction: $e_{am}^- + NH_3 = NH_2^- + 1/2H_2$ and 3×10^9 for the reaction $Na^+ + e_{am}^- + NH_3 = NaNH_{2(c)} + 1/2H_2$ at 25°. By determining the temperature dependence of the electron concentration in these solutions a heat of solution of −19 kcal was estimated for the first reaction and −12 kcal for the second. Dissert. Abstr.

N68-26190 California Univ., Berkeley.
IONIC RECOMBINATION IN WEAKLY IONIZED GASES
George Ayrs Fisk (Ph.D. Thesis) 1966 75 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-8555

This paper reports a study of ionic recombination rates in the lead iodide, lead bromide, and thallium iodide systems. The pressure dependence of the ion–ion recombination coefficient α was studied in the lead iodide system at 594°K and in the lead bromide system at 707°K. In both cases xenon at pressures up to 150 torr and argon at pressures up to 400 torr were used as third body gases. In all cases the recombination coefficient could be expresses as $\alpha = \alpha_0 + \alpha' \times N$ where N was the number density of the third body gas (atoms/cm^3). Currently available theories do not predict these values. The temperature dependence of α was studied in the thallium iodide system over the range 484°K to 728°K. No simple theoretical or empirical expression describes the dependence of α on T over this range, although α decreases with increasing temperature over most of the range, as predicted by theory. Dissert. Abstr.

N68-26203 IIT Research Inst., Chicago, Ill.
MOLECULAR ORBITAL STUDIES ON TITANIUM-OXYGEN SYSTEMS
Yu-ping Hsia (Ph.D. Thesis) 1967 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8448

Extended Hückel Molecular Orbital calculations have been performed on localized TiO_6^{-n} units with the precise geometry of such a unit in solid rutile, anatase and brookite TiO_2, tetragonal $BaTiO_3$ and solid Ti_2O_3. The relative values of one-electron energy levels in these compounds are obtained in terms of a "self-consistent" charge and population calculation. Examination of the resulting energy levels, charge distributions and bond orders has led to reasonable explanations of previously unexplained data on (1) the visible and near-ultraviolet absorption spectra of these compounds, (2) the low energy X-ray absorption edges of rutile, anatase and brookite TiO_2, (3) the infrared absorption spectra of CO and CO_2 chemisorption on rutile and anatase TiO_2, (4) the pressure dependence of the absorption edges of rutile TiO_2 and tetragonal $BaTiO_3$ and (5) the relative heats of formation of anatase, rutile and brookite TiO_2. Dissert. Abstr.

N68-26224 Washington State Univ., Pullman.
LOW TEMPERATURE INVESTIGATION AND NORMAL COORDINATE ANALYSIS OF THE INFRARED SPECTRUM OF CRYSTALLINE HYDRAZINE
Frank Geile Baglin (Ph.D. Thesis) 1967 100 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-9161

A great deal of confusion has surrounded the molecular structure of hydrazine due in part to its reactivity and in part to its ability to form rotational isomers. In this investigation, 95% hydrazine was dried with sodium hydroxide or potassium hydroxide pellets, sublimed onto either cesium bromide or rock salt plates, and the infrared spectra recorded. Spectra were recorded of solid

hydrazine at −16°C, −30°C, −78°C, and −196°C (all temperatures refer to the cryostat). The various infrared spectral bands of the stable crystalline phases were analyzed by three normal coordinate treatments carried out by a high speed digital computer. The analysis of the spectrum to decide upon the rotameric configuration present in solid hydrazine was accomplished at the low frequency end of the spectrum, rather than the more usual approach of examining the high frequency end of the spectrum. Dissert. Abstr.

N68-26225 Arkansas Univ., Fayetteville.
STRUCTURE OF SURFACE SPECIES. A STUDY OF MOLECULES ADSORBED ON EVAPORATED FILMS OF VANADIUM, CHROMIUM AND MANGANESE BY INFRARED TECHNIQUES
Marvin Carrol Allen (Ph.D. Thesis) 1967 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8723

The infrared spectra of surface species which were formed by the chemisorption of methanol, ethanol, n-propanol, 2-propanol, n-butanol, i-butanol, t-butanol, allyl alcohol, acetaldehyde, propionaldehyde, acetone, methyl ethyl ketone, methyl vinyl ether, ethylene oxide, propylene oxide, carbon dioxide and carbon monoxide on vanadium, chromium and manganese have been obtained. No observable surface species were found for diethyl ether and tetrahydrofuran. All of these compounds were absorbed at 25°C. The absorbents used were metallic films of vanadium, chromium and manganese. These films were evaporated, in the presence of helium, into a hydrocarbon oil medium. After evaporation, the films were exposed to the oxygen containing compounds of interest. Dissert. Abstr.

N68-26239# Atomic Energy Commission, Oak Ridge, Tenn. Div. of Technical Information Extension.
SUMMARIES OF THE USAEC BASIC RESEARCH PROGRAM IN CHEMISTRY (OFF SITE)
Apr. 1968 186 p refs
(TID-4005, Pt. 2A, 3 ed.) CFSTI: HC $3.00/MF $0.65

The summaries are presented under the following headings: heavy-element chemistry; nuclear chemistry; radiation, photo, and hot-atom chemistry; structural and theoretical chemistry; isotope-effects chemistry; high-temperature chemistry; inorganic chemistry; physical chemistry; analytical chemistry; separations and geochemistry; and nuclear-engineering chemistry. Corporate author, investigator, and subject indexes are included. NSA

N68-26242# Franklin GNO Corp., West Palm Beach, Fla.
AN EXPERIMENTAL STUDY OF THE BEHAVIOR OF LARGE NEGATIVE IONS Final Technical Report, 15 Jun. 1965–14 Jul. 1967
Rama K. Asundi, Robert W. Crowe, and Martin J. Cohen 15 Dec. 1967 22 p refs
(Contract Nonr-4924(00))
(AD-668339)

Electron attachment properties and mobility studies of ions, formed in high molecular weight fluorocarbon compounds and drifting through a light medium, were made using a drift tube experiment. The reduced mobilities are found to be lower than the predictions of the small ion theory of Langevin. Using the experimentally determined mobility, the stage efficiency, and pressure ratios for a linear EHD device were evaluated when the device uses ions formed in Freon E-3. Author (TAB)

N68-26280 Michigan Univ., Ann Arbor.
AN ELECTRON SPIN RESONANCE STUDY OF VANADIUM IN CALCIUM TUNGSTATE CRYSTAL
Nasser Mahootian (Ph.D. Thesis) 1966 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8308

In this study, the electron spin resonance (ESR) spectrum of vanadium is investigated in single crystals of calcium tungstate. To produce vanadium paramagnetic centers, the samples were irradiated. It is believed that vanadium enters the crystal in diamagnetic pentavalent (V^{5+}) oxidation state and the observed spectra are due to the irradiation-produced V^{4+} ($S = 1/2$). Three vanadium paramagnetic centers were detected, with the corresponding spectra designated as Groups A, B, and C. This group is attributed to V^{4+} ions at W^{6+} sites, i.e., to VO^{4-} complexes. The Group B lines, shown by the (V,RE)-doped samples only, arise from two unequivalent sites. The Group C lines are seen in the spectra of the samples in which vanadium is the only dopant or there is an excess of this element over the RE ions. This group arises from four nonequivalent sites. From the ESR data the models are proposed for site occupancies and charge compensation in $CaWO_4$. Dissert. Abstr.

N68-26302# Oak Ridge National Lab., Tenn.
INCREASE OF THE DETECTION EFFICIENCY IN THE USE OF SULFUR AS A FAST NEUTRON DETECTOR
V. Kadlec and P. Otopal [1967] 27 p refs Transl. into ENGLISH of Cesk. Akad. Ved, Rez Rept. UJV-1546
(ORNL-TR-1842; UJV-1546) CFSTI: HC $3.00/MF $0.65

Sulfur activation detector efficiency may be increased by separating the sulfur from the phosphorus-32 by combustion of the sulfur. The effect of the conditions of combustion of sulfur tablets on the yield of ^{32}P, and the losses of radioactive phosphorus are determined (7%). The counting rate of ^{32}P was measured continuously during the fusion and combustion of the tablets. It is concluded that the fast-neutron detection efficiency can be raised by about four orders of magnitude by combustion. Author (NSA)

N68-26305# Argonne National Lab., Ill.
THERMODYNAMIC STUDIES OF THE URANIUM–OXYGEN SYSTEM USING MASS SPECTROMETRY [ETUDES THERMODYNAMIQUES PAR SPECTROMETRIE DE MASSE SUR LE SYSTEME URANIUM–OXYGENE]
A. Pattoret, J. Drowart, and S. Smoes Jan. 1968 41 p refs Transl. into ENGLISH of Brussels Univ. Rept. No. SM-98/49. Presented at the Symp. on Thermodyn. of Nucl. Mater. with Emphasis on Solution Systems, Vienna, 4–8 Sep. 1967
(Contract AF 61(052)-764)
(ANL-TRANS-561; CONF-670915-8; SM-98/49) CFSTI: HC $3.00/MF $0.65

Determinations were made of the vapor pressures of the gaseous species U, UO, UO_2, and UO_3 over different phases of the uranium–oxygen system: U–O solution, two-phase system U(l) and UO_{2-x}(s), single-phase UO_{2-x} between $UO_{2.00}$ and the limiting composition at 1700° to 2500°K. The pressures of U, UO, and UO_2, expressed in atm, are given by equations: log P_U = 25.955/T + 5.85, (1700 to 2340°K); log P_{UO} = 28.280/T + 8.19, (1700 to 2100°K); and log P_{UO_2} = 30.850/T + 8.60 (1900 to 2400°K). The dissociation energies of the UO and UO_2 molecules are independently specified through isomolecular exchanges with Si and SiO_2. The consistency between the heat of sublimation of U, ΔH_s, O(U) = 128.5 kcal/g-atom and the thermodynamic data for uranium carbides is discussed. Above 2100°K, vapor-pressure measurements on the two-phase system U(l) + UO_{2-x}(s) reflect the development of a distinct nonstoichiometry in the dioxide. The ratios of the pressures of UO_2(g) over congruent $UO_{2.00}$, UO_{2-x} and at the limit of the UO_{2-x} area measured by different techniques are given as are the corresponding compositions at the phase limit and at the congruent evaporation point. The oxygen partial pressures and the partial thermodynamic functions of the nonstoichiometric dioxide are given as a function of the composition. Author (NSA)

N68-26313# Aerospace Corp., El Segundo, Calif. Lab. Operations.
FREE RADICAL YIELDS IN POLYTETRAFLUOROETHYLENE AS THE BASIS FOR A RADIATION DOSIMETER
Henry S. Judeikis, Herbert Hedgpeth, and Seymour Siegel Feb. 1968 39 p refs
(Contract F04695-67-C-0158)
(SAMSO-TR-68-140; TR-0158(3250-20)-6; AD-668109)

Exposure of polytetrafluoroethylene (PTFE) to ionizing radiation results in chemical degradation of the polymer and formation of long-lived free radicals. The paper describes the use of quantitative measurements of the electron spin resonance (ESR) spectra of the free radical produced in irradiated PTFE to determine radical yields and attempts to correlate these radical yields with the absorbed radiation dose. The experimental results indicate sufficient correlation over the experimental range rad to permit use of PTFE as a passive radiation dosimeter. The advantages inherent in the use of the PTFE dosimeter for the measurement of low energy electromagnetic or particulate radiation are also discussed. Energy deposition as a function of depth from the incident surface can be determined by sectioning of the polymer after irradiation. The resulting dose - depth curves can then be used to obtain spectral and profile data from polychromatic sources. Author (TAB)

N68-26326 California Univ., Berkeley.
ADSORPTION OF GASES ON HOMOGENEOUS AND HETEROGENEOUS SURFACES
Sadok Ephraim Hoory (Ph.D. Thesis) 1966 178 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-8580

Monolayer gas adsorption on homogeneous and heterogeneous solid surfaces has been studied. The first part reports experimental data for monolayer adsorption of ethylene, ethane, propylene, propane, isobutane and n-butane on homogeneous graphitized carbon. Henry's constants, lateral interaction parameters, and heats and entropies of adsorption were calculated. Part 2 presents a study of the effect of surface heterogeneity on the adsorption isotherm at very low coverage. Two extensions are presented to Ross' theoretical model of surface heterogeneity. In the third part, a systematic thermodynamic treatment is described for mobile, monolayer adsorption of gas mixtures on homogeneous and heterogeneous surfaces. Part 4 presents a molecular thermodynamic treatment of chemisorption with special reference to first- and second-order chemical surface kinetics. Rate equations are derived.
Dissert. Abstr.

N68-26347# Air Force Systems Command, Wright–Patterson AFB, Ohio. Foreign Technology Div.
NEW IRON-CONTAINING MONOMERS AND POLYMERS FROM FIVE-MEMBERED NAPHTHENES [NOVYYE ZHELEZOSODERZHASHCHIYE MONOMERY I POLIMERY IV PYATICHLENNYKH NAFTENOV]
Ya. M. Paushkin and T. P. Vishnyakova 29 Aug. 1967 16 p refs Transl. into ENGLISH from Inst. Neftekhimicheskoy i Gazovoy Promyshlennosti. Tr. (Moscow), no. 44, 1963 p 15–26
(FTD-HT-67-171; AD-668062)

The alkylation of ferrocene by different olefins (iso- C4H8, iso-C5H10, and iso-C8H16) in the presence of 25% H3PO4 is described. BF3 at the optimum conditions of 60C and a 5-hr. agitation period, is compared. With an increase in olefin molecular weight, there is a decrease in alkylate yield and ferrocene conversion accompanied by an increase of monoalkylferrocene content. The physical-chemical properties of the prepared alkylferrocenes are listed. Ferrocene and alkylferrocene were then used to obtain ferrocenyl-containing polymers by the polyrecombination reaction which consists of peroxide treatment at 170-200C. The joint polyrecombination of ferrocene with paradichlorobenzene, diphenol, alpha-bromonaphthalene and quinoline was also investigated and the data are tabulated. Soluble polymers were obtained by the polycondensation of ferrocene with acetone in the presence of ZnCl2 +HCl. The preparation of polyferrocenylvinylene from acetylferrocene is described. Author (TAB)

N68-26386# Air Force Cambridge Research Labs., Bedford, Mass
CUPROUS CHLORIDE IN HYDROCHLORIC ACID: ANALYSIS AND SOLUBILITY
J. J. O'Connor, A. Thomasian, and A. F. Armington Feb. 1968 11 p refs *Its* Phys. Sci. Res. Papers No. 352
(AFCRL-68-0089; AD-668093)

A new method of analysis for cuprous and hydrogen ion concentration gives rapid results, with no interference between ions. A solubility curve for cuprous chloride as a function of hydrochloric acid concentration was worked out. Author (TAB)

N68-26395 Cornell Univ., Ithaca, N. Y.
CHEMICAL AND PHYSICAL STUDIES OF OXYGEN-DEFICIENT TANTALUM PENTOXIDE
Daniel Robert Kudrak (Ph.D. Thesis) 1967 85 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-2713

The tantalum-oxygen system was investigated with the purposes of preparing oxides lower than Ta_2O_5 and of characterizing the mechanism of electron transport in the oxides. Initial experiments indicated that it was not feasible to oxidize tantalum metal to an intermediate oxidation state. Later efforts were concentrated on finding a suitable reducing agent for the pentoxide, Ta_2O_5. A variety of reducing agents was tried in the temperature range 1000°–1500°C, all without success. It was concluded that the lower oxides previously reported, e.g., TaO and TaO_2, do not exist under ordinary conditions. It was found that fusion of Ta_2O_5 powder (melting point approximately 1850°C) in a tantalum container in high vacuum produced a hard, black, lustrous, crystalline material. This product was a rather good electrical conductor (room temperature resistivity 4.5×10^{-2} ohm-cm.) and increased in weight when heated in oxygen. The product was a non-stoichiometric form of the high temperature phase of Ta_2O_5 involving interstitial tantalum. Dissert. Abstr.

N68-26396 Cornell Univ., Ithaca, N. Y.
THE DIRECT MEASUREMENT OF A BIPHOTONIC PHOTOIONIZATION IN LIQUID SOLUTION AND SOME STUDIES ON ELECTRICAL CONDUCTIVITY IN LOW DIELECTRIC CONSTANT, ORGANIC SOLUTIONS
Herschel Sydney Pilloff (Ph.D. Thesis) 1967 145 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-6433

Flash-photoconductivity studies in liquid solutions are reported. These studies relate primarily to the production of charge and the mechanics of the conduction process. It was found that a dilute solution of N, N, N', N'-tetramethyl- p -phenylene diamine (TMPD) in 3-methylpentane (3-MP) at room temperature could be photoionized by light quanta with energies which were as little as one-half those required for gas phase ionization. In order to satisfy the energy requirements, the possibility that two photons might be involved in the photoionization was considered. The mechanism of this two photon photoionization has also been investigated. It was found that the monomeric form of the solute was ionized and not states of higher aggregation. Also, the possibility of delayed ionization resulting from the diffusive encounter of two one-photon excited molecules has been eliminated. Dissert. Abstr.

N68-26406# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AN ANALYSIS OF THE COMBINATION SCATTERING SPECTRUM OF DIMETHYL BENZENE

Wen-pai Liu, Pao-zen Chang, and Yu-chuen Wang 3 May 1967 15 p refs Transl. into ENGLISH from Hua Hsueh Tung Pao (Peking), no. 1, 1966 p 30–34
(FTD-HT-66-800; AD-668097)

Quantitative analysis of Raman spectra is based on the principle that a compounds content is proportional to its spectral intensity, which is also closely related to the equipment used and to operating conditions. A Hilger E-612 spectrograph with an FL-1 type low voltage mercury lamp as the light source was used to study those factors affecting the intensity of Raman spectra and the suitable operating conditions for this equipment. Intensities of Raman spectra of some hydrocarbons thus collected were found to agree with the reported data. Intensity of Raman spectra was determined by comparing it with that of fluorescence spectra of the standard substance. The Raman spectra were taken by exciting the strongest mercury line of 4358 angstrom and a saturated aqueous solution of sodium nitrite was used as the light filtering liquid. The fluorescence spectra utilized excitation of the mercury line of 3650 angstroms of quinine sulfate fluorescence and a solution of 1 mole of cupric nitrate and 2.5 moles of ethylene diamine was used as the light filtering liquid. Quantitative analysis of optical mixtures, mixtures of known composition, and xylene produced as a by-product by a steel mill was satisfactorily conducted. Hydrocarbons of low aliphatic content may directly undergo Raman spectral analysis with good results without chromatographic fractionation. Author (TAB)

N68-26413# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
ETCHING BEHAVIOR OF In_2O_3 GROWN FROM PbO–B_2O_3
Armond B. Chase and James R. Teviotdale Mar. 1968 18 p refs
(Contract F04695-67-C-0158)
(TR-0158(9230-03)-4; SAMSO-TR-68-165; AD-668449)

Single crystals of In2O3 grown from a PbO-B2O3 solution are etched by HNO3 or HNO3-HCl solutions. Characteristic etch pits and etch tubes are described. The number of etch pits is found to be related to the growth history of the crystals. The relationship of the etch tubes to crystal growth is discussed. Author (TAB)

N68-26420# Argonne National Lab., Ill. Chemistry Div.
ANION-EXCHANGE BEHAVIOR OF TRANSPLUTONIUM ELEMENTS AND LANTHANIDES IN HYDROCHLORIC ACID-ORGANIC SOLVENT MIXTURES
K. A. Orlandini and J. Korkisch Jan. 1968 12 p refs
(Contract W-31-109-ENG-38)
(ANL-7415)

The influence of 20 water-miscible organic solvents on the adsorption of tervalent transplutonium and rare earth elements from hydrochloric acid media was investigated using Dowex 1 as the exchange resin. From the distribution coefficients that were determined in various organic solvent–hydrochloric acid mixtures, the conditions most suitable for a group separation of the transplutonium elements from the lanthanides are indicated. The best separation possibilities exist in mixtures that consist of 75 or 60% acetone and 25 or 40% concentrated hydrochloric acid and are 2*M* in lithium chloride. Under these conditions, the separation factors of the pair americium–ytterbium was 28.8 and 21.5, respectively, the former being higher by about a factor of 4 than that obtained in pure aqueous lithium chloride media. So far, however, separation experiments conducted by using this fact have not produced satisfactory results because of a considerable tailing effect in the elution of ytterbium. Author (NSA)

N68-26424 California Univ., Berkeley.
MEASUREMENT OF FLUID SATURATIONS BY NUCLEAR MAGNETIC RESONANCE AND ITS APPLICATION TO THREE-PHASE RELATIVE PERMEABILITY STUDIES
Deoki Nandan Saraf (Ph.D. Thesis) 1966 108 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8644

A nuclear magnetic resonance (n.m.r) technique for measuring liquid saturation in porous materials has been examined. The intensity of the n.m.r. absorption signal was found to depend linearly on the number of hydrogen atoms present in the liquid within the pore spaces when the liquid did not contain any free ions. In the presence of a dissolved electrolyte, the intensity of the absorption signal was found to depend on the number of ions present in the sample. A possible explanation for such a dependence of n.m.r. signal on salt concentration is suggested in terms of a change in the dielectric properties of the sample. By maintaining a low and almost constant concentration of electrolytes in the water phase during relative permeability measurements it was possible to use n.m.r. methods to measure the amount of water, oil, and gas in the pore spaces. For a better understanding of multiple-phase fluid flow in underground petroleum reservoirs, relative permeability data are essential. Using n.m.r. methods, two- and three-phase relative permeabilities have been measured on Boise sandstone. Dissert. Abstr.

N68-26425 Houston Univ., Tex.
THE DEVELOPMENT AND CHARACTERIZATION OF A PHOTOIONIZATION DETECTOR FOR USE IN GAS CHROMATOGRAPHY SYSTEMS
John G. W. Price (Ph.D. Thesis) 1966 174 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-2036

A comprehensive study has been made of a photoionization detector for gas chromatography systems. Initial characterization of detector geometry and operating parameters was accomplished using a flexible breadboard apparatus. Three optimized detector designs which resulted were subjected to comparative evaluations. Sample response was almost three orders of magnitude higher than those of commercial flame ionization detectors. Best performance was achieved by operating at reduced pressures using a DC discharge in argon and employing hydrogen as the carrier gas. The use of helium and other sources of high energy photons as discharge gases appeared considerably complicated by even trace amounts of impurities. Successful applications were made in the fields of air pollution analyses and in the analysis of hydrocarbons extracted from meteorites. The extreme sensitivity and potential selectivity of this detector recommend it highly for use in chromatographic systems. Dissert. Abstr.

N68-26443# Ballistic Research Labs., Aberdeen Proving Ground, Md.
DETERMINATION OF PRINCIPAL REACTION IN 4:1 MIXTURES OF N_2 AND O_2 DURING AND AFTER PULSED IONIZATION
Franklin E. Niles Dec. 1967 67 p refs
(BRL-R-1387; AD-667961)

Computer solutions were obtained for 15 simultaneous differential equations which describe the time rate of change of electrons, NO2(-), O(-), O2(-), O3(-), N2(+), NO(+), O(+), O2(+), N, NO, N2O, NO2, O, and O3 during and after pulsed ionization. The calculations were made for a 4:1 mixture of N2 and O2 at a total pressure of 5 Torr. Ionization was repetitive at a rate of 8.05 x 10 to the 9th power ion pairs/cu cm/sec for about a half second and zero for about a half second. The number densities at the end of the sixth pulse of ionization were used as initial number densities for calculations in which ionization was not applied. These calculations yield the afterglow solutions. The afterglow solutions reveal that (1) NO(+) is the only important positive ion throughout the afterglow period, (2) the most important negative ion changes progressively with time from O2(-) to O3(-) to NO2(-), and (3) other than N2 and O2, NO is the most important neutral species throughout the afterglow with NO2 and N2O being the only other

neutrals remaining in the very late afterglow. The interconnection of the ions and neutrals via reactions during the early afterglow is shown by a schematic diagram. Author (TAB)

N68-26465# European Atomic Energy Community, Karlsruhe (West Germany). European Inst. for Transuranium Elements.
FORMATION OF COLLOIDAL SOLUTIONS OF Pu^4 AND THE CONVERSION INTO PuO_2 MICROSPHERES
K. P. Louwrier, T. Steemers, and E. Zamorani Brussels Jan. 1968 17 p refs
(EUR-3737.E)

Different methods to produce sols of PuO_2 are presented and the feasibility of forming microspheres is tested. Formation of microspheres with a tapered column and in a beaker is described. Thermogravimetric analysis in connection with the drying procedure is discussed. Metallographic inspection of the microspheres is presented. Author (NSA)

N68-26516*# Stanford Univ., Calif.
DYNAMICS OF SELECTIVE MOLECULAR EXCITATION: LASER PHOTOCATALYSIS OF BROMINE REACTIONS
William B. Tiffany May 1967 146 p refs
(Grant NsG-331)
(NASA-CR-94928; ML-1538) CFSTI: HC $3.00/MF $0.65 CSCL 07D

A frequency-tuned, high repetition rate ruby laser was designed and used as a light source for the selective photocatalysis of gas-phase reactions between bromine and certain unsaturated fluorocarbons. The purpose was to demonstrate for the first time the usefulness of highly monochromatic, tunable laser light for selective molecular excitation. In the 14,400 cm^{-1} region of the ruby laser, bromine absorption occurs in individual lines belonging to the $^3\Pi_1 \leftarrow {}^1\Sigma_0^+$ band system. In this study, certain lines were identified as belonging to particular isotopic species of bromine molecules. It was not known if weak continuous absorption, indicative of direct dissociation, also occurs in the same spectral region. Absorption of the laser light by the bromine caused it to react with the fluorocarbon. Either perfluorobutene or heptafluorochlorobutene was used, and they gave essentially the same results. This was the first reported photochemical reaction of bromine in the 14,400 cm^{-1} region. When the laser frequency was tuned to coincide with individual absorption lines, the reaction rate was considerably enhanced. This showed that the primary photochemical process was the formation of stable excited bromine molecules with energies 500 to 800 cm^{-1} below the dissociation level. Author

N68-26547# Oak Ridge National Lab., Tenn. Gaseous Diffusion Plant.
IMPROVED TECHNIQUES FOR CORROSIVE FLUORIDE GAS CHROMATOGRAPHY
W. S. Pappas and J. G. Million [1968] 14 p refs Presented at the 155th Natl. Meeting of the Am. Chem. Soc., San Francisco
(Contract W-7405-ENG-26)
(K-L-6183; CONF-680308-6) CFSTI: HC $3.00/MF $0.65

Several new techniques are described which broaden the applicability of gas chromatography to corrosive fluoride gases. Columns prepared with Teflon-6 support were applied. A new column utilizing fluorocarbon oil instead of the conventional chlorofluorocarbon oil as the liquid phase is described, with application to inorganic and organic fluorine compounds. The loss of small amounts of certain reactive fluoride gases was found due principally to sorption on system surfaces, rather than on the column packing. Replacement of metal tubing with Teflon tubing reduced sorption losses, markedly improving detectability limits for these constituents. A two-step column technique sped up analysis, without fraction storage, when late eluders were present. Author (NSA)

N68-26552# Wake Forest Coll., Winston-Salem, N. C.
[ON PHYSICAL CHEMISTRY] Summary Progress Report, 15 Nov. 1966–15 Nov. 1967
Howard W. Shields and Phillip J. Hamrick, Jr. 15 Nov. 1967 6 p refs
(Contract AT(40-1)-2835)
(TID-24147) CFSTI: HC $3.00/MF $0.65

A study of a $-\dot{N}-H$ type radical in irradiated semicarbazide is reported. An attempt to study a $-\dot{N}-H$ type radical in nitrourea was unsuccessful since it was impossible to grow single crystals of nitrourea. The hydrogen–deuterium exchange in α-ureidopropionic acid was studied. After x-irradiation of α-ureidopropionic acid at room temperature the α-propionyl radical was found. When the radicals were formed in deuterated crystals, the observed spectra changed as the crystal was heated. After several hours of heating, equilibrium was reached, and 80% of the radicals contained deuterium in the α-position. An activation energy of 13 kcal/mole was found for the exchange of hydrogen with a neighboring deuterium. Free radicals of the type R_2CCONH_2 were identified in X-irradiated single crystals of propionamide, n-butyramide, and isobutyramide. Principal values of the hyperfine coupling constants and their direction cosines with respect to the assigned axes were determined. NSA

N68-26565# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
EXCIMER EMISSION OF NAPHTHALENE, ANTHRACENE, AND PHENANTHRENE CRYSTALS PRODUCED BY VERY HIGH PRESSURES
Peter F. Jones and Malcolm Nicol (Calif. Univ., Los Angeles) Feb. 1968 36 p refs
(Contracts F04695-67-C-0158; AT(11-1)-34)
(TR-0158(9250-01)-4; SAMSO-TR-68-161; AD-668448)

Fluorescence spectra of ultra-pure crystals of naphthalene, anthracene, and phenanthrene were studied at pressures as great as 50 kbar. These spectra exhibit complex irreversible effects superimposed upon the expected reversible shifts in the energies of the normal fluorescence spectra. The irreversible effects include a loss of the intensity of the normal fluorescence with increasing pressure and the almost simultaneous appearance of a broad, featureless emission at energies about 3000 to 6000/cm lower than that of the normal fluorescence. This emission is assigned as the fluorescence of excimers formed upon optical excitation of the crystals under high pressure. The crystals continue to exhibit this excimer fluorescence after the pressure is reduced to atmospheric pressure, but the irreversible effects can be removed by thermal annealing of the crystal at atmospheric pressure. The irreversibility is attributed to trapping of pairs of molecules in an excimer-like orientation as a crystal defect after they lose the excitation energy of the excimer. These defects then act as traps for excitation energy in the crystal. Other possible interpretations of the irreversible effects are discussed. Author (TAB)

N68-26579# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SURFACE IONIZATION OF IODINE AND SODIUM ON AN INCANDESCENT POLYCRYSTALLINE TANTALIC THREAD [POVERKHNOSTNAYA IONIZATSIYA IODA I NATRIYA NA RESKALENNOY POLIFRISTALLICHESKOY TANTALOVOY NITI]
Ye. P. Sytaya and N. G. Shuppe 9 Jun. 1967 18 p refs Transl. into ENGLISH from Tr. Tashkent Univ. Nauch. (USSR), no. 221, 1963 p 103–112
(FTD-MT-67-58; AD-668504)

The work presents the results of investigations of the negative ionization of iodine atoms and positive ionization of sodium atoms on an incandescent surface of tantalum, which were undertaken for the purpose of evaluating the magnitude of minimum and

maximum work functions of the electrons of surface spots, and the portions of the surface occupied by these spots on a polycrystalline tantalic thread heated by alternating current. Author (TAB)

N68-26581# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

KINETICS OF ELECTRODE PROCESSES

A. N. Frumkin, V. S. Bagotskiy, Z. A. Iofa, and B. N. Kobanov 7 Aug. 1967 555 p refs Transl. into ENGLISH from the Book "Kinetika Elektrodnykh Protsessov" Moscow, Izd. Mosk. Univ., 1952 p 1–319

(FTD-HT-67-153; AD-668917)

Contents: Basic properties of the surface layer at the interface between a metal and a solution; Diffusion kinetics; Polarography; Hydrogen overvoltage; Reactions of electrochemical reduction and oxidation; Evolution of gas bubbles at the electrode and wetting of metals by electrolytes; Electrodeposition of metals; Passivation and kinetics of electrode processes; Kinetics of the dissolution of metals. TAB

N68-26659# Nuclear Materials and Equipment Corp., Lewistown, N. Y. Niagara Div.

MATERIAL BALANCE: BORON ISOTOPE SEPARATION COLUMNS, AUGUST 1966–FEBRUARY 1967

Jerome J. Hoynacki 15 Apr. 1967

(Contract AT(40-1)-3292)

(NUMEC-3292-3) CFSTI: HC $3.00/MF $0.65

A continuing mass balance has been made on the boron isotope separation columns since October 28, 1966. The data covering earlier periods are included for comparative information. Tables summarize the results for each period. Graphs show the influence of the cooling water temperature on the vent loss. Diagrams show the distribution of mass and boron-10 for the period October 28, 1966 to March 1, 1967. An accountability for more than 99.9% of the mass and 97% of the boron-10 entering the system has been attained. The vent stream has been reduced to 50% of its previous value. The four long periods studied (October, November through December, January, and February) had 10.68, 20.97, 17.41, and 16.04% recoveries respectively of boron-10 from the feed material. The last two reported periods may be considered more typical as the plant was near steady state with only natural complex being used as feed. NSA

N68-26675# Union Carbide Corp., Oak Ridge, Tenn. Gaseous Diffusion Plant.

AUTOMATIC PROCESS CHROMATOGRAPHS FOR THE ANALYSIS OF CORROSIVE FLUORIDE GASES

J. G. Million, W. S. Pappas, and C. W. Weber 1968 18 p refs Presented at the 155th Natl. Meeting of the Am. Chem. Soc., San Francisco, 31 Mar.–5 Apr. 1968

(Contract W-7405-ENG-26)

(K-L-6182; CONF-680308-4) CFSTI: HC $3.00/MF $0.65

An automatic process gas chromatograph is described, capable of sampling from corrosive gas systems ranging in pressure from subatmospheric to several atmospheres. The instrument is mobile and essentially self-contained. Provision for column selection and for continuous control of sample pressure and flow allows application to a wide variety of problems. A special gas sampling system was selected to satisfy requirements for leak tightness in sub-atmospheric sampling. Particular attention is given to the problem of obtaining representative samples from highly reactive gas systems. Applications of instruments of this type at the Oak Ridge Gaseous Diffusion Plant include the identification of halocarbon coolant leaks into the uranium hexafluoride process gas. Special techniques yield a coolant sensitivity of 20 ppM and an analytical cycle of 1-1/2 minutes. Author (NSA)

N68-26686# Junta de Energia Nuclear, Madrid (Spain). Direccion de Quimica e Isotopos.

SEPARATION OF HYDROGENATED TERPHENYLS BY GAS CHROMATOGRAPHY AND INTERPRETATION OF THEIR INFRARED AND ULTRAVIOLET SPECTRA [SEPARACION DE TERFENILOS HIDROGENADOS POR CROMATOGRAFIA DE GASES E INTERPRETACION DE SUS ESPECTROS DE INFRARROJO Y ULTRAVIOLETA]

L. Gasco Sanchez and R. Parellada Bellod [1966] 15 p refs In SPANISH Presented at the Intern. Atomic Energy Agency Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, 9–13 May 1966

(CONF-660553-5)

In the separation of commercial mixtures of hydrogenated terphenyls [HB-40 (Monsanto) and OMP-H (Progil)] satisfactory results were obtained, as regards the collection of fractions, using columns 2 m in length packed with 20% Apiezon L on Chromosorb and, as regards total separation, using Apiezon L Macrogolay columns. The relative retentions, determined at temperatures between 185 and 300°C, for the components of a mixture of triphenylmethane and anthracene were investigated in columns of Apiezon L, silicone SE-30, SE-31 and W-95, and silicone oil SF-96. The infrared and ultraviolet spectra of the components were studied, the following structures being assigned to them in the order of their appearance in the chromatogram: *o*-terphenyl, *o*-phenylcyclohexylbenzene, *m*-dicyclohexylbenzene, phenylcyclohexylcyclohexane, *p*-dicyclohexylbenzene, m-phenylcyclohexylbenzene, and p-phenylcyclohexylbenzene. Author (NSA)

N68-26712# California Univ., Santa Barbara. Dept. of Chemistry.

ENVIRONMENTAL EFFECTS ON PHOSPHORESCENCE. 2: ACTIVATION VOLUMES FOR TRIPLET DECAY OF AROMATIC HYDROCARBONS

B. A. Baldwin and H. W. Offen 22 Mar. 1968 13 p refs Submitted for publication

(Contract N00014-67-A-0120-0001)

(TR-10; AD-667975)

The rate of triplet decay k was measured to 32 kbar for twenty aromatic hydrocarbons at room temperature. The measured lifetimes are generally shortened by high pressure. The slope of lnk vs. P plots were all linear above 15 kbar. This slope is positive except for terphenyl, and can be related to activation volumes Delta-$V^{\ddagger}$ for this kinetic process. The values $-1.0 < \text{Delta-}V^{\ddagger} < 0.2$ cu. A/molecule are found for this class of compounds. The perdeuterated compounds have a larger negative activation volume than the corresponding perprotonated aromatics. Hence, environmental perturbations are most effective for slow processes which arise from weak intramolecular perturbations in the solute. Author (TAB)

N68-26719# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

SOME STATISTICAL PROBLEMS IN MASS SPECTROMETRY

John J. Jeach [1968] 16 p Presented at the 155th Natl. Meeting of the Am. Chem. Soc., San Francisco, 4 Apr. 1968

(Contract AT(45-1)-1830)

(BNWL-SA-1717; CONF-680308-2) CFSTI: HC $3.00/MF $0.65

It is shown how information in sets of data on uranium isotopes may be extracted using the Poisson distribution of the pulse count data from a mass spectrometer. Four statistical problems are covered: bias control with cusum charts, comparison of two methods of reading beams, detection of abnormalities in data, and optimum allocation of effort. NSA

N68-26724# Junta de Energia Nucleare, Madrid (Spain). Direccion de Quimica e Isotopos.

MASS SPECTROSCOPIC ANALYSIS OF THE VOLATILE PRODUCTS OF PYROLYSIS OF POLYPHENYLS [ANALISIS POR ESPECTROMETRIA DE MASAS DE PRODUCTOS VOLATILES PROCEDENTES DE LA PIROLISIS DE POLIFENILOS]

H. G. Sanz [1966] 10 p refs In SPANISH Presented at the Intern. Atomic Energy Agency Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, 9–13 May 1966

(CONF-660553-6)

Mass spectrometry was applied to analyzing the volatile components of the products of polyphenyl pyrolysis. In the gaseous fraction the following components were found: hydrogen, paraffins C_1 to C_4, olefins C_2 to C_4, alcohol benzenes C_6 to C_8, carbon monoxide and dioxide, nitrogen, argon, air, and water. A total of 18 components was identified. In the liquid fraction the principal component was benzene, with small quantities of toluene, ethylbenzene, xylenes, normal and isopropyl benzene, naphthalene, and biphenyl. The experimental conditions and the methods of calculation used for the two types of samples, are described. Author (NSA)

N68-26725# New Mexico Univ., Albuquerque.

STUDIES OF SOLUTE-SOLVENT INTERACTIONS IN NON-AQUEOUS SOLVENTS, JULY 1, 1967-JANUARY 15, 1968

N. E. Vanderborgh and W. D. Spall 15 Jan. 1968 66 p refs Prepared for Sandia Corp., Albuquerque, N. Mex.

(Contract AT(29-1)-789)

(SC-CR-68-3521) CFSTI: HC $3.00/MF $0.65

Ultrasonic apparatus was constructed and experiments were carried out to determine the equilibrium constants for association of various phenols in low-dielectric constant nonaqueous solvents. Phenol, nitrophenol, and chlorophenol dissolved in cyclohexane, carbon tetrachloride, and benzene were studied. NSA

N68-26727# Texas A&M Univ., College Station. Dept. of Chemistry.

CHEMISTRY OF THE METALLOIDS OF GROUP 5A AND GROUP 6A Progress Report, 1 Jan.–31 Dec. 1967

Ralph A. Zingaro 31 Dec. 1967 23 p refs

(Contract AT(40-1)-2733)

(ORO-2733-13) CFSTI: HC $3.00/MF $0.65

The formation constants and thermodynamic data were measured for complexes formed between trisubstituted phosphine selenides and iodine. The results are consistent with the stronger donor capabilities predicted for phosphine selenides. A computer program for vibrational analysis of polyatomic molecules was tested. Reactions of some organophosphorus compounds with alkali metals in tetrahydrofuran and the free radicals formed are being investigated by ESR spectroscopy. An improved analytical method for the determination of arsenic in organic compounds was developed. Heats of fusion and of transition of the C_1 to C_{20} arsinic acids are discussed as a basis for postulating molecular structure of these molecules. NSA

N68-26729# California Univ., Berkeley. Lawrence Radiation Lab.

ARC SPECTRUM OF MAGNESIUM OXIDE

David W. Green Feb. 1968 62 p refs

(Contract W-7405-ENG-48)

(UCRL-17878, Rev.) CFSTI: HC $3.00/MF $0.65

A comparison of the observed molecular electronic states of magnesium oxide is made to the states predicted by theoretical considerations. The observations reported are incomplete and considerable uncertainty exists about the states below 10 kK (10,000 cm^{-1}). Low-lying triplet states were predicted on the basis of atomic states of the separated atoms and semiempirical molecular orbital considerations. Assignments were made to a number of observed but previously unassigned band heads in the violet spectrum of MgO. Band heads were observed in the region from 2600° to 2800° Å which cannot be attributed to a known transition. The possible assignment of the C and D states of magnesium oxide to triplets was considered. Relative intensities of the violet, green and red band systems of MgO are reported. Second differences for the C and D states were calculated from the previously reported rotational lines. Intensity calculations were performed for the branches of a $^3\Sigma - ^3\Pi$ electronic transition with the $^3\Pi$ state intermediated between Hund's coupling cases (a) and (b). Author (NSA)

N68-26735*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

IMIDAZOPYRROLONE/IMIDE COPOLYMERS

Vernon L. Bell 1967 17 p refs Presented at the Baltimore-Washington Sect. of the Soc. of Plastics Engr. Regional Tech. Conf., Washington, D. C., 7–8 Sep. 1967

(NASA-TM-X-60445) CFSTI: HC $3.00/MF $0.65 CSCL 07B

A series of copolymers containing imidazopyrrolone and imide groups was prepared by the solution polymerization of pyromellitic dianhydride with mixtures of 3, 3', 4, 4'-tetra amino diphenyl ether and p, p'-oxydianiline, respectively. Tensile properties of thin films of the copolymers were measured: a general increase in tensile modulus and a decrease in elongation with increasing imidazopyrrolone content was noted. The copolymers were more resistant to degradation by strong acids and bases than the corresponding polyimide. The thermal stabilities of the copolymers in air increase with increasing imide content while in vacuum the thermal stabilities were greater for imide-rich copolymers below 600°C but greater for imidazopyrrolone-rich copolymers above 625°C. Author

N68-26737 Utah Univ., Salt Lake City.

OPTICS IN SIGNIFICANT STRUCTURE THEORY OF LIQUIDS: PART 1. SIGNIFICANT STRUCTURE THEORY OF ISOTOPE EFFECT. PART 2: THE SIGNIFICANT STRUCTURE AND PROPERTIES OF LIQUID HYDRAZINE AND LIQUID DIBORANE. PART 3: THE SIGNIFICANT STRUCTURE THEORY APPLIED TO THE HYDRIDES OF THE ELEMENTS OF THE FIFTH GROUP

Joseph Water Grosh (Ph.D. Thesis) 1967 102 p

Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8488

With the use of a simple visualized significant structure model of liquids, the isotopic vapor pressure differences of various liquids have been successfully explained. Using the technique appearing in the theory, the author found that the vapor pressure differences are mainly affected by E_s, the heat of sublimation, but secondarily by the molecular structure parameters such as the moment of inertia, I, and the mass of isotopic molecules, m. The significant structure theory of the liquid is shown to be applicable also to rocket fuels such as liquid hydrazine and liquid diborane over the entire liquid range. The following properties were calculated and compared with experiment with good agreement: Vapor pressure, molar volume, entropy, the critical constants, heat capacity at constant volume and constant pressure, thermal coefficient of expansion, and compressibility. The significant structure theory has been applied to the liquid state of PH_3, AsH_3, and SbH_3. The molar volume, vapor pressure, specific heat, entropy, and critical properties for the liquids are calculated. Dissert. Abstr.

N68-26742 Louisiana State Univ., Baton Rouge.

DETERMINATION AND IDENTIFICATION OF FUNDAMENTAL AMINO ACIDS BY THERMOMETRIC TITRATION AND NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

William Yong-chien Wu (Ph.D. Thesis) 1967 90 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8805

Methods for quantitative determination of amino acids utilizing the acid-base neutralization reaction, and the metal ion (Cu +2) chelation have been developed. Individual and binary mixtures have been investigated. Potentialities and limitations of the methods have been explored in terms of analytical precision, accuracy and range of application. In general, the thermometric titration technique proves to be a sensitive, rapid, simple and reliable method for the quantitative determination in the 10^{-2} and 10^{-4} range, and sample size of 25 ml. The method is of particular value for routine analysis. Proton nuclear magnetic resonance spectroscopy has been chosen as an ideal tool for qualitative identification. Twenty fundamental amino acids have been studied, and qualitative assignment of the absorption peaks are made and explained. A table has been compiled to relate all the absorption peaks of all the acids. Binary mixtures of various combinations show characteristic cumulative absorption spectra, allowing identification of the individual components. t-Butyl alcohol has been used as the reference standard. Dissert. Abstr.

N68-26743 California Univ., San Diego.
THEORETICAL AND EXPERIMENTAL STUDIES ON OPACITIES OF SIMPLE MOLECULES
D. S. Prasad Varnasi (Ph.D. Thesis) 1967 180 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-7839

A highly simplified procedure using symmetrical band contours and intensity estimates derived from harmonic oscillator approximations, has been used to calculate band and total emissivities for CO_2 and H_2O at sufficiently high pressures where the rotational fine structure has been removed. Agreement with experimental data is excellent. The empirically determined dependence of total emissivities on the partial pressure of water vapor, at constant total pressure, is accounted for quantitatively by using a model of randomly distributed dispersion lines falling in the square root region of the curves of growth. The influence of (partial) overlapping of spectral lines in CO_2–H_2O mixtures has also been calculated. Simplified calculations lead to acceptable agreement with Hottel's empirical correlations at elevated temperatures ($T = 1200°K$) where only the 2.7μ bands of H_2O and CO_2 are overlapped. On the other hand, comparisons at 811°K indicate that serious discrepancies exist in the 15μ region between Hottel's correlations and approximate calculations based on recent spectroscopic measurements on H_2O. Dissert. Abstr.

N68-26781# New Mexico Univ., Albuquerque. Dept. of Chemistry.
INVESTIGATION OF ORGANIC THERMOCHROMIC MATERIALS
B. D. West Feb. 1968 11 p ref Prepared for Sandia Corp., Albuquerque, N. Mex.
(Contract AT(29-1)-789)
(SC-CR-68-3520) CFSTI: HC $3.00/MF $0.65

The chemical change in 3,5-diphenyl imidazoline-4 responsible for its thermochromism was studied and analogous materials were prepared. The presence of a strong base shifted the thermochromic phenomenon of these compounds to lower temperatures. NSA

N68-26820# California Univ., Berkeley. Lawrence Radiation Lab.
MOLECULAR BEAM STUDIES OF SCANDIUM MONOFLUORIDE
David W. Green (Ph.D. Thesis) Jan. 1968 79 p refs
(Contract W-7405-ENG-48)
(UCRL-17961) CFSTI: HC $3.00/MF $0.65

The molecular beam method used previously to fix the electronic groundstate of lanthanum monoxide was modified and extended to scandium monofluoride. King furnace equilibrium studies of the intensities of the green $^1\Pi - {}^1\Sigma^+$ and red $^3\phi - {}^3\Delta$ transitions gave the relative transition probabilities from both absorption and emission. From this data the expected relative intensity of the transitions in the molecular beam was calculated assuming no radiative intersystem decay. The relative fluorescent intensity at various molecular beam path lengths indicates that both the $^1\Sigma^+$ and $^3\Delta$ states of ScF persist at least as long as 10^{-4} seconds. A maximum energy separation has been estimated to be 3,000 K (cm^{-1}). The thermodynamic free-energy function is dependent upon the degeneracies and energies of these low-lying electronic states. It was indicated that the partition function should include electronic, vibrational, and rotational contributions from both the $^1\Sigma^+$ and $^3\Delta$ states. In addition, an unobserved $^1\Delta$ state should be thermodynamically important. Free-energy functions were calculated using the best data available. It was estimated that the $^1\Pi - {}^1\Delta$ transition has a small f-value and will be weak in emission compared to the $^1\Pi - {}^1\Sigma^+$. The ratio of the f_{abs} value of the $^3\phi - {}^3\Delta$ to that of the $^1\Pi - {}^1\Sigma^+$ is 0.8 ± 3. Author (NSA)

N68-26848# Texas Nuclear Corp., Austin.
CONTINUOUS, ON-LINE, NUCLEAR ANALYSIS MEASUREMENTS IN PROCESS CONTROL APPLICATIONS Interim Technical Report, 1 Mar. 1966–31 May 1967
Troy C. Martin, J. R. Rhodes, and J. B. Waters 31 Jul. 1967 88 p refs
(Contract AT(40-1)-2980)
(ORO-2980-16; ITR-4) CFSTI: HC $3.00/MF $0.65

Research into the applications of nuclear analysis techniques to on-line process control problems has been continued. Modifications to the solids presentation system have increased its versatility in that a much wider variety of different materials, a larger range of particle sizes (up to 1 inch) and a wider range of sample weights and flow rates can now be handled. A closed or open circuit slurry loop has been designed, tested and installed. Using it, aqueous slurries of ores and minerals can be presented continuously to the neutron source and gamma spectrometer. On-stream determination of silicon in taconite (iron ore) has been shown feasible. Materials analyzed include cement raw mix, bauxite, coal, tar sands, copper ore and taconite. Preliminary results show promise for on-line continuous analysis of several of these materials. Author (NSA)

N68-26861# Pennsylvania Univ., Philadelphia.
THE FORMAL EVALUATION OF A SIMPLE CHEMICAL CIPHER SYSTEM
James Munz Apr. 1968 42 p refs
(Grant NSF GN-520)

Two systems of notation for chemical structure were evaluated with respect to completeness, uniqueness, and ambiguity. A precise set of rules for generating the non-unique expressions of Hiz's notation, with slight modifications, is presented along with a proof that the system is complete with respect to an easily characterizable set of graphs. The basic system is extended to include more structures and, then, to a unique system with alternating encoding rules. The set of graphs is specified and the rules for non-unique encoding of H are presented, with H referring to the cipher system that contains all the expressions which were generated in the Hiz system. A detailed syntactic analysis is included. An H'' system is then considered that consists of the original encoding rules for H, the syntactic processing rules, and the rules for generating an expression when given an H expression and its syntactic analysis. M.W.R.

N68-26936 Cornell Univ., Ithaca, N. Y.
POTASSIUM–ARGON AGES OF IRON METEORITES

Louis Albert Rancitelli (Ph.D. Thesis) 1967 90 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-9195

A method to determine the potassium–argon of iron meteorites is described. The meteorite, after irradiation in a reactor, is subjected to a nitric acid dissolution rather than a vaporization to facilitate removal of the argon and potassium. Using this method the potassium–argon ages of several iron meteorites were determined. The results range from 3 billion years to 15.6 billion years. The potassium–argon ages determined for the meteorite Weekeroo Station were found to disagree with the strontium–rubidium age of the silicate inclusions in this meteorite. The spatial distribution of potassium in several iron meteorites as well as its mobility under leaching conditions were studied. The results indicate potassium is highly concentrated in grain boundaries and inclusions. Distilled water can remove as much as 80% of the potassium in a specimen in 4.5 hours. A theory to account for the distribution and mobility of potassium in iron meteorites is presented. The conclusion of this theory is that the potassium–argon ages of iron meteorites are anomalously high. Weathering and handling of the meteorite results in preferential potassium loss and hence high ages. Dissert. Abstr.

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N68-25680*# Houston Univ., Tex. Dept. of Electrical Engineering.
ANALOG AND DIGITAL SIMULATIONS OF MULTIPLEX SYSTEM PERFORMANCE
S. Riter, R. D. Shelton, and T. Williams 1967 26 p refs Presented at the IEEE Intern Conf. on Commun., Minneapolis, Jun. 1967
(Grant NGR-44-005-039)
(NASA-CR-87716) CFSTI: $3.00 CSCL 17B

Generalized multiplexing system models allow an additional degree of flexibility for the communication system designer. For channels with a single constraint, such as limited bandwidth, it is possible to determine optimum multiplexing systems. For more complicated channels with a combination of constraints, simulation programs are often the best way to select the best multiplexing system and to determine its performance. Results are presented for both analog and digital simulations as an example of the procedures involved. The system used as an example is based on the real exponential set of orthonormal waveforms. Author

N68-25744*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ERROR CORRECTION FOR DEEP SPACE NETWORK TELETYPE CIRCUITS
Harold Fredricksen 1 Jun. 1968 20 p refs
(Contract NAS7-100)
(NASA-CR-94920; JPL-TR-32-1275) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The design of a system for controlling errors in teletype transmission is described. A code with high error-correction capability was developed following an analysis of the error statistics of the channel. That code is detailed, the decoding algorithm is given, a communications processor for directing communications within the station is described, and the performance of the code and operation of the communications processor on a set of coded messages transmitted from an overseas site are reported. Author

N68-25768*# National Aeronautics and Space Administration, Washington, D. C.
SPEECH COMMANDS IN CONTROL SYSTEMS [USTNYYE KOMANDY V SISTEMAKH UPRAVLENIYA]
E. Kyunnap Apr. 1968 33 p refs Transl. into ENGLISH from Izv. Akad. Nauk Eston. SSR, Ser. Fiz.-Mat. i Tekhn Nauk (Tallinn), v. 15, no. 3, 1966 p 377–399
(NASA-TT-F-11252) CFSTI: $3.00 CSCL 17B

Literature dealing with automatic recognition of speech sounds is received. The problem of increasing channel carrying capacity is considered. A study is made of the mechanism of sound formation. The principles of operation of bandpass, format, scanning, harmonic and correlation voice coders are outlined. A number of signal devices for recognizing speech signals are described, and the use of universal computers as a means of studying and recognizing speech signals is discussed. Author

N68-25779*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE ASEE-UNIVERSITY OF MARYLAND-CATHOLIC UNIVERSITY-NASA SUMMER FACULTY FELLOWSHIP PROGRAM Final Report, Jun. 12–Aug. 18, 1967
J. C. Morakis, comp. Apr. 1968 240 p refs
(NASA-TM-X-63228; X-520-68-179) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Active research and seminar participation are conducted as a means of stimulating universities to become interested in the research being conducted by the Goddard Space Flight Center, and conversely to stimulate the Goddard professional staff through associations with university faculties. A series of papers are presented covering workshop efforts on real time computer systems, mathematical models of very low frequency wave propagation, electric fields in the lunar atmosphere, relative phase difference analysis, experimental determination of PCM signal to noise ratio, adaptive techniques to improve antenna servo accuracy, retrodirective antennas and the multipath problems associated with their use on the proposed Orbiting Data Relay Network, transfer functions of the Rosman 1 antenna structure, and spatial light modulation using a ferromagnetic fluid. Abstracts are included on research pertaining to optical communications, data storage, PCM telemetry, automatic processing of ionograms, and bit error probability tests. M.G.J.

N68-25780*# Missouri Univ., Columbia.
A SURVEY ON SOME MATHEMATICAL MODELS OF THE VERY LOW FREQUENCY WAVE PROPAGATION
David H. S. Cheng *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1–43 refs (See N68-25779 15-07)

Experimental efforts in the field of very low frequency (VLF) wave propagation are reviewed, and the development of four mathematical models is discussed. These are: (1) The waveguide mode theory model is based on the concept of the classical residue series. However, a disadvantage is seen in the need for solving the transcendental equation in order to account for the various modes necessary in evaluating the electromagnetic fields. (2) The zonal harmonic series is formulated on the modern theory of the non-self-adjoint operators, and relies only on the original harmonic series for its solution. (3) The eigenfunction method also contains a transcendental equation. However, a mixed method, using the data of the short range fields and some known parameters to determine the unknown parameters, simplifies the solution. (4) The full wave theory places stress on the computational aspects of the problem. It is pointed out that current theories are incapable of explaining such phenomena as the diurnal and seasonal variations of the long distance VLF field, and the effect of the solar flare on both the field strength and the phase. M.G.J.

N68-25784*# Missouri Univ., Rolla. Electrical Engineering Dept.
AN INVESTIGATION OF METHODS FOR THE EXPERIMENTAL DETERMINATION OF PCM SIGNAL TO NOISE RATIO
Jack F. Morris *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1968 p 89–103 refs (See N68-25779 15-07)

An overview is presented on the approaches used in examining the telemetry link and identifying the sources and nature of the noise at each stage of the data path through the receiver system to the analog data tape. Calculated and measured signal to noise ratios (SNR) were compared, and nonuniform discrepancies were found to exist between the calculated SNR and the observed bit error rate. By using the receiver system in the Information Processing Division, experimental values of SNR improvement through the pulse modulation demodulator were achieved. Trade-off between the system accuracy required to obtain a very slight improvement and the minor degradation experienced using the wider band system settings definitely favored the latter. To the PCM signal and noise characteristics of actual flight data recorded on magnetic tape, computer programs and digital techniques were developed for determining signal amplitude probability distributions over any desired segment of analog data, obtaining bit-by-bit statistics within the frame sync pattern, and performing spectral analysis of the data.
M.G.J.

N68-25786*# Rutgers Univ., New Brunswick, N. J.
ON THE USE OF ADAPTIVE TECHNIQUES TO IMPROVE ANTENNA SERVO ACCURACY
H. J. Perlis *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1968 p 123–143 refs (See N68-25779 15-07)

The basic antenna tracking system is analyzed under various conditions. The study suggests some desirable relationships to maintain within the framework of the existing configuration. In order to improve performance under different tracking environments an executive form of adaption is recommended. This employs available external information in a scheme to generate an adjustment vector in the tracking servo system.
Author

N68-25787*# Norwich Univ., Northfield, Vt.
RETRODIRECTIVE ANTENNAS AND THE MULTIPATH PROBLEMS ASSOCIATED WITH THEIR USE ON THE PROPOSED ORBITING DATA RELAY NETWORK
P. M. Seal *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1968 p 145–160 (See N68-25779 15-07)

The available literature on retrodirective arrays was surveyed, and a bibliography report is included to describe the highlights of each reference. Various aspects of the multipath problem were studied to determine the extent to which the beam steering of the retrodirective array would be affected by the reflected wave. A determination was made of the maximum angle ($\Delta\theta$) between the path taken by the direct wave and the path taken by a reflected wave arriving from the specular point. Equations were derived from the multipath geometry, and the $\Delta\theta$ was calculated as a function of the angle of incidence (θ) for the case of a target vehicle assumed to be 400 miles above the earth. Equations derived for obtaining $\Delta\theta$ are extended to obtain equations for calculating the differential Doppler frequency or fading rate. A figure is included to show how fading bandwidth and coherent bandwidth vary with the roughness of the sea. An assessment is also made of a frequency-hopping technique proposed to take advantage of the time delay between the direct signal and the reflected signal.
M.G.J.

N68-25788*# George Washington Univ., Washington, D. C.
TRANSFER FUNCTIONS OF THE ROSMAN 1 ANTENNA STRUCTURE
T. G. Toridis and Yu Chen (Rutgers Univ., New Brunswick, N. J.) *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1968 p 161–183 (See N68-25779 15-07)

A simplified model of the antenna structure was developed, in which each substructure is replaced by one or more points or lumped masses. The mass of the structure is lumped on each of 13 points, located on the x-wheel bearings, hydraulic drive, x-wheel counterweight, reflector dish, y-wheel counterweight, y-wheel bearings, and feedbox. Consisting of 39 degrees of freedom, the model yields natural frequencies encompassing the experimentally observed frequency range. In order to use a simple eigenvalue routine, the influence coefficient matrix is forced into symmetrical form. Tabulations of the resulting matrix are included. Equations are formulated for determining the free vibrations, the forced vibrations, and the transfer functions. Based on this analysis, a computer program was developed to calculate the natural frequencies and modes of vibration, and the transfer matrix of the system.
M.G.J.

N68-25794# Carleton Univ., Ottawa (Ontario). Faculty of Engineering.
RECEPTION OF DIGITAL SIGNALS OVER RANDOMLY TIME VARIANT DISPERSIVE CHANNELS
A. Roger Kaye Apr. 1968 236 p refs Sponsored by NRC
(E-68-1) CFSTI: HC $3.00/MF $0.65

A canonical form is obtained for the optimum linear receiver for the problem of signalling by pulse amplitude modulation over a randomly time variant dispersive channel. The receiver consists of a bank of filters, whose outputs are sampled and fed to a weighting network which forms a set of estimates. This structure applies for all linear media whether exactly known or random. When the medium is wide sense stationary and sequential signalling is used, the receiver can be reduced to a single filter followed by a tapped delay line. The problem of receiver design is reduced to the solution of an integral equation for each filter response and of a set of simultaneous algebraic equations for the weighting network. An expression is obtained for the estimation error which is shown to approach a non-zero limit as the transmitter power is increased. Results are obtained for a class of systems with no intersymbol interference. The characterization and effects of randomness of communication channels and the estimation error dependence on space and time correlation properties of the channel are discussed.
R.N.A.

N68-25802*# International Business Machines Corp., Gaithersburg, Md. Federal Systems Div.
ADAPTIVE COMPRESSIVE TELEMETRY TECHNIQUES
Final Report
31 Aug. 1966 197 p refs
(Contract NAS9-4618)
(NASA-CR-65498) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Various data compression techniques were evaluated to determine their effects on the information or signal being transmitted, and fidelity criteria for evaluating the compression algorithms are defined with attention centered mainly on geometric aperture techniques and quasi-analytical methods. Digital computer simulation was used to evaluate the direct data and transformation compression methods, using medical, experimental, and engineering conntrol data considered typical for future manned spacecraft. These techniques were assessed on the basis of peak and rms error versus compression, as well as estimated implementation complexity. A tradeoff analysis was made to compare the significant aspects of various data compressors, and the problems of adaptive buffering and control of compression parameters are examined. Basic design data are presented on a complete, adaptive data compression system. Although the study demonstrated that no

single compression method is best for all space telemetry data, two relatively simple aperture techniques were found to provide the maximum compression. M.G.J.

N68-25804# Saab Aircraft Co., Linkoping (Sweden).
SOME PROPERTIES OF PHASE-AMPLITUDE MONOPULSE RADAR
Sven G. Gustafsson Sep. 1967 49 p refs
(SAAB-TN-64) CFSTI: HC $3.00/MF $0.65

The most commonly used monopulse radars with capability to determine two angular coordinates use four antennas and three amplifier channels. It was early pointed out that two angular coordinates could be measured with a monopulse radar using only two antennas and two amplifier channels. This radar is sometimes named phase amplitude monopulse, PHAM. The present paper is devoted to a description of the main principles and angle measuring properties of the PHAM. General expressions for the output signals including important nonlinearities are derived. The expressions are valid for complex targets. Also included in the investigation are the most important types of equipment imperfections as well as target noise. Some comments are made on the target resolution capabilities of the PHAM. A significant property of the PHAM is that a difference in phase lag between the two channels results in an apparent rotation of the angular coordinates of the target direction. The geometrical angle of rotation becomes equal to the difference in phase lag. Very important is that the target noise (glint and fading) in the PHAM is cross-coupled between the two main planes. This may result in very high values of the rms angular error as measured in units of angular target span. Author

N68-25805*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PRECISION POWER MEASUREMENTS OF SPACECRAFT CW SIGNAL WITH MICROWAVE NOISE STANDARDS
C. T. Stelzried, M. S. Reid, and D. Nixon 15 Feb. 1968 68 p refs
(Contract NAS7-100)
(NASA-CR-94921; JPL-TR-32-1066) CFSTI: $3.00 CSCL 17B

Determination of the absolute level of the received CW power is one of the important measurements required in the evaluation of a spacecraft communications system. A new, precise measurement method that compares CW signal power with microwave noise power is described. This technique, together with statistical methods of data reduction, results in significantly increased accuracy. The overall probable error of the measurement was reduced from 0.8 to 0.3 dB defined at the receiver input for an antenna receiving system at the JPL Goldstone Deep Space Communications Complex. Application of these techniques to Mariner IV began on June 29, 1965, and was continued after Mars encounter. The theory, equipment, and method of data acquisition and reduction are described, and results and accuracies are discussed. The Mariner IV-received power at Mars encounter normalized for 100% antenna efficiency was −154.2 dBmW, as compared to a theoretically predicted level of −153.1 dBmW. Author

N68-25814# Institute for Perception RVO-TNO, Soesterberg (Netherlands).
COMPARATIVE TEST OF THROAT MICROPHONES OF THE TYPES AMPLIVOX (EL. DYN.) AND ELNO (CARBON; EL. DYN.) [VERGELIJKEND ONDERZOEK VAN KEELMIKROFOONS, TYPEN AMPLIVOX (EL. DYN.) EN ELNO (KOOL; EL. DYN.)
T. Houtgast and H. J. M. Steeneken 1968 5 p In DUTCH; ENGLISH summary
(IZF-1968-1; TDCK-50099, 2) CFSTI: HC $3.00/MF $0.65

Three types of throat microphones were subjected to a comparative test. The microphones are to be used in combination with the intercom AM-65/GRC in AMX armored cars. The method was based on intelligibility tests with PB words. Noise was introduced in order to simulate the field conditions in AMX armored cars. The Amplivox (electrodynamic) and ELNO (carbon) were found to be nearly equal; the results obtained with those two types are slightly better than the results obtained with the ELNO (electrodynamic). It is indicated that a reduction of the amplitude of the microphone signal delivered to the intercom will improve the intelligibility. Author

N68-25852*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
CODING SCHEMES FOR RUN-LENGTH INFORMATION BASED ON POISSON DISTRIBUTION
W. W. Happ Washington Jun. 1968 19 p refs
(NASA-TN-D-4572) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The Shannon-Fano-Huffman Redundancy Reduction Procedure is extended to one-parameter and two-parameter Poisson distribution resulting from run-length information streams. Figures-of-merit are established to compare Huffman coding to fixed-word-length binary coding on the basis of (1) average number of coding digits per message, (2) signal-to-noise ratio in analog-to-digital conversion due to bit errors, and (3) design criteria primarily of interest to the system designer and not readily amenable to quantitative analysis. To ascertain whether or not Huffman coding leads to a unique and optimum code, other equally good optimum solutions were obtained. Optimization and uniqueness criteria are examined and applications to data compression are discussed. Author

N68-25881# Edgerton, Germeshausen and Grier, Inc., Boston, Mass. Eastern Science and Technology Div.
A TECHNIQUE FOR RADIATING AN ISOLATED PULSE OF ELECTROMAGNETIC FIELD
C. S. Fitzgerald 27 Dec. 1967 58 p refs
(Contract AT(29-1)-1183)
(EGG-1183-428; B-3719) CFSTI: HC $3.00/MF $0.65

This waveform is produced to calibrate extremely broadband systems for measuring electromagnetic fields. The technique involves the generation of a traveling wave on a vertical cone antenna joined at its extreme ends by a horizontal, open wire transmission line. Analytical predictions are compared with experimental results. NSA

N68-25918*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN OMNIDIRECTIONAL FLUSH-MOUNTED MICROWAVE ANTENNA WITH A SIMPLE FEED FOR USE ON SPACECRAFT
C. R. Cockrell and W. F. Croswell Washington Jun. 1968 28 p refs
(NASA-TN-D-4555) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The qualitative theory, design, and development of a parallel-plate waveguide-fed antenna, suitable for flush-mounted broad-band spacecraft applications are presented. The antenna makes use of wedge-like metal posts placed uniformly about the periphery of the feed plates to provide both structural strength and practical interconnection routes for cables without disrupting the antenna impedance and patterns. Measurements taken on the antenna which is mounted on spheroids up to 50 wavelengths in circumference are presented, equatorial patterns are omnidirectional within ±0.25 dB, and polar patterns have beam widths similar to a half-wave dipole. Author

N68-25936*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
HIGH DATA RATE STORAGE SYSTEM (ENGINEERING MODELS EM-1 AND EM-2) Final Report, 5 Mar. 1964–31 May 1967

1967 202 p refs
(Contract NAS5-3772)
(NASA-CR-95056) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Performance test data are presented on the high data rate storage system (HDRSS) engineering models, EM–1 and EM–2, which consist of a five-track tape recorder and a five-channel, frequency-division multiplexer. Details are given on the modifications made to existing Nimbus 1 and 2 ground stations, and on the bench check and integration test equipment. System integration tests consisted of operational tests for the EM–1 and EM–2, and thermal tests for the EM–2. The data show that the image dissector (ID) and high resolution infrared (HRIR) channels can meet the amplitude response specifications. Analytical data are also included on the performance parameters for the ID and HRIR channels, and the flutter and wow of the time code channel; interferometer spectrometer channel data and the signal-to-noise ratio requirement; and S-band transmitter deviation schedule parameters and the corresponding signal-to-noise ratios. M.G.J.

N68-25955 State Univ. of Iowa, Iowa City.
PURE TONE MASKING AND SIGNAL DETECTION THEORY
Julius Anthony Canahl, Jr. (Ph.D. Thesis) 1967 78 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-9048

Changes in the underlying distribution functions used by a subject in the detection of a sinusoidal signal when a sinusoidal masker was added to a wideband noise masker were studied. ROC curves reflecting the underlying distribution functions for two masking situations were derived using a six interval rating scale technique. A 500 Hz sinusoidal signal, with an "a priori" probability of occurrence of 0.5, was adjusted to provide approximately the same level of detectibility for each masking situation. Comparison of the obtained ROC curves for the two masking conditions did not show differences in form, indicating that there were no changes in the form of the underlying distributions. Dissert. Abstr.

N68-25981 Michigan Univ., Ann Arbor.
A STRUCTURAL THEORY FOR THE PERCEPTION OF MORSE CODE SIGNALS AND RELATED RHYTHMIC PATTERNS
Myron Wish (Ph.D. Thesis) 1966 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8370

The primary purpose of this dissertation is to develop a structural theory, along facet-theoretic lines, for the perception of Morse Code signals and related rhythmic patterns. As steps in the development of this theory, models for two sets of signals are proposed and tested. The first model is for a set comprised of all signals of the International Morse Code (IMC) in addition to some similar dot-and-dash patterns. The second model is for a set comprised of 32 Morse-like rhythmic patterns in which the silent intervals between the dots and dashes can be either short or long. In the present investigator's experiment, 324 female undergraduates at the University of Michigan enrolled in introductory psychology courses were presented pairs of the Morse-like rhythmic patterns, rather than pairs of IMC signals, and were instructed to indicate whether they perceived the signals of each of these pairs as same or different. Dissert. Abstr.

N68-25984# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
THE EFFECT OF LINEARITY ASSUMPTIONS AND UNKNOWN NOISE SOURCES ON KALMAN FILTERING IN ORBIT DETERMINATION
W. O'Dwyer, J. Mendelsohn, and A. Kaercher May 1967 24 p refs Presented at the Am. Astronautical Soc. 1967 Natl. Symp., Huntsville, Ala., 12–14 Jun. 1967
(RE-285J)

Previous results of the authors have shown the tendency of state variable estimates obtained via Kalman filtering to diverge from the true state variables. In this report an attempt is made to uncover the source of this problem. Particular attention is directed toward assessing the effect of linearity assumptions inherent in the derivation of the filter and "computation noise" which arises during the actual machine computation. Conclusions on the relative importance of these two error sources are arrived at through a simulation of a lunar orbit determination problem. Author

N68-25995 Michigan Univ., Ann Arbor.
ADMITTANCE OF A WEDGE EXCITED CO-AXIAL ANTENNA WITH A PLASMA SHEATH
Chi Fu Den (Ph.D. Thesis) 1966 146 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8240

This investigation is a theoretical study of the terminal admittance of a wedge waveguide in a perfectly conducting cylinder. We formulate two coupled integral equations of the Fredholm type with the wedge aperture field and shell slot field as the unknown functions. Only one of the integral equations contains the source term and we call that one the inhomogeneous integral equation. The other one we refer to as the homogeneous integral equation. Two forms of the terminal admittance of the wedge waveguide are formulated from the inhomogeneous integral equation. An approximate solution was obtained for the shell slot field from the homogeneous integral equation. From the stationary form of the terminal admittance the calculations of the terminal admittance of the wedge waveguide are carried out. We conclude that: the circular shell behaves as a tuning element; the conductance and susceptance are weakly dependent on the thickness of the plasma sheath when $\omega > \omega p$. When $\omega < \omega_p$, either an increase of the sheath thickness or the plasma density will make the conductance decrease exponentially for a collisionless plasma. Dissert. Abstr.

N68-26068 George Washington Univ., Washington, D. C.
LIMITS IN REAL-TIME DIGITAL FILTERING OF NON-STATIONARY RANDOM PROCESSES
Kuno Manfred Roehr (Ph.D. Thesis) 1967 177 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-8827

Practical methods of digitally filtering nonstationary and transient stationary processes in real-time situations have been presented. The outstanding feature of the developed filters is that they have the inherent capability to adapt their structure to changing input signal situations. The developed method is based on extensions of Wiener's theory of mean-square filtering. Signal statistics can be time-varying and instead of the generally time-varying mean-square error a more suitable weighted sum is used as optimizing criterion. Inherent errors due to noise are derived. Additional errors arising in real-time adaptive filtering situations are the result of insufficient signal statistics. The conclusions drawn are that the optimum time-variable filter can significantly improve on the signal-to-noise performance of the fixed filter only if the time spread of the signal covariance coefficients is sufficiently large. On the other hand the real-time measurement errors increase with increasing time-spread of the covariance coefficients. The combination of these two observed facts seems to place severe limits on the effectiveness of adaptive real-time filtering. Dissert. Abstr.

N68-26069 University of Southern Calif., Los Angeles.
INTEGRAL TRANSFORMS RELATED TO THE RADAR AMBIGUITY FUNCTION

Lucius Kennedy Montgomery, Jr. (Ph.D. Thesis) 1967 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-8016

A 2n-dimensional generalized ambiguity function of signals of n variables is defined. The term generalized applies because an arbitrary kernel of an n-dimensional unitary transformation can be used in the definition of the ambiguity function. A special case of the generalized ambiguity function is the Fourier ambiguity function which is obtained by using the n-dimensional Fourier transform kernel as the unitary transformation kernel in the definition of the generalized ambiguity function. The radar ambiguity function is a 2-dimensional Fourier ambiguity function. A short development is presented for an (m + n)-dimensional generalized cross-ambiguity function and a discrete-continuous ambiguity function. Several classes of integral transforms are developed. Necessary and sufficient conditions for a function to be transformable or to be a transform for these classes of integral transforms are proved. Dissert. Abstr.

N68-26173# Federal Aviation Administration, Atlantic City, N. J.
INVESTIGATION AND EVALUATION OF ASR/ARSR PERFORMANCE MONITOR Final Report
William F. Herget and L. Domenick Apr. 1968 31 p refs
(NA-68-8; RD-68-24)

An FA-5170 Radar Performance Analyzer was investigated to determine causes for poor field operation and its suitability as a basis for development of a new ASR/ARSR Radar Performance Monitor. Some of the circuitry and techniques employed in the Radar Performance Analyzer are satisfactory, while others are inadequate or require redesign. It was recommended that a proposed model, as described in this report, form the basis for a new Performance Monitor. Author

N68-26174# Federal Aviation Administration, Atlantic City, N. J.
NIMBUS 2 VHF MULTIPATH INVESTIGATIONS Final Report
Thomas H. Barton and Francis W. Jefferson May 1968 51 p refs
(NA-68-16; RD-68-30)

The Federal Aviation Administration conducted an over ocean and limited over land flight test program to obtain data on performance degradation of VHF radio frequency satellite-to-aircraft communication links resulting primarily from multipath propagation fade effects. The Nimbus II satellite was used to provide a signal source for the measurements which were made in an instrumented aircraft equipped with a conventional VHF blade antenna and a special design circularly polarized satellite communications antenna. In addition to the acquisition of multipath data, the aircraft received a real time printout of Nimbus Automatic Picture Transmission System weather pictures. Data were obtained for varying satellite azimuth angles with the elevation angles ranging from near grazing to 90 degrees. The special airborne satcom antenna was used in both the low and high elevation angle operation modes with results indicating only minor fades of 1 dB or less in the high angle mode. Author

N68-26184 California Univ., Berkeley.
THEORY OF SPIRAL ANTENNAS
Yu-Shuan Yeh (Ph.D. Thesis) 1966 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8677

This thesis presents the results of a complete investigation of conical equiangular spiral antennas. The integral equation method is applied to find the rigorous solution of the current distribution. A new method of numerical interpolation is introduced, which enables the integral equation method to calculate antennas up to 10 wavelength. The theoretical study reveals an important general behavior of the current on the spiral antennas. This discovery enables the characterization of a spiral antenna by simple design curves, despite the numerous parameters involved in the antenna. The final application of the results of this investigation is also supplemented by a special variational integral which gives quick direct means of finding the input impedance of almost any equiangular spiral antennas. Dissert. Abstr.

N68-26193 California Univ., Berkeley.
PULSED DETECTION RADAR WITH FEEDBACK
Stephen Brant Weinstein (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-8668

In an effort to extend the information-feedback investigations of G. L. Turin to the case of target detection, a coherent pulsed detection radar is proposed in which the amplitude of each member of the transmitted pulse train is a function of the receiver output measured just prior to its transmission. Variational problems for the (N-1) functions which determine the amplitudes of the second, third, ..., N^{th} pulses in an N-pulse train are developed for a likelihood-ratio detector and for a modified correlation detector, but because of the difficulties of solution in the general case, only an information-theoretic upper bound on the average energy saving of an N-pulse system with respect to a no-feedback system, and a lower bound derived from a sub-optimal set of amplitude functions, are presented. For N=2, the variational problems are solved numerically and energy-saving curves are presented for appropriate combinations of false-alarm and detection probabilities. The variational problem for the optimum amplitude function in a two-pulse incoherent detector is also developed, but no data are computed. Dissert. Abstr.

N68-26199# Rydbeck Research Associates, Fjaras (Sweden).
SIGNAL DISTORTION IN ANISOTROPIC HOMOGENEOUS IONIZED MEDIA. PART 1: LONGITUDINAL MAGNETIC FIELD
Bernt O. Roennaeng 25 Apr. 1967 58 p refs
(Contract AF 61(052)-864)
(AFCRL-67-0579; SR-7; AD-668455)

This report deals with propagation of electro-magnetic transients in anisotropic, homogeneous ionized media. Due to a longitudinal, external magnetic field in incident signal will be split up into two circularly polarized modes, which propagate independently in the homogeneous medium. By means of the saddle-point method of integration approximate expressions for the transmitted signal in the medium have been obtained. These results have been used to calculate the distorted and time-delayed unit step modulated carrier and the distorted pulse-carrier in the layer in the isotropic as well as the anisotropic case. The split-up into a left-hand polarized and a right-hand polarized pulse is shown in a series of figures. Author (TAB)

N68-26200# Stanford Research Inst., Menlo Park, Calif.
AUTOMATED CURTS HF: REAL-TIME MANAGEMENT AND ADMINISTRATION OF HF SYSTEMS AND FREQUENCY RESOURCES, PART 3 Final Report
T. I. Dayharsh, J. L. Gnagy (Defense Commun. Agency), and S. E. Probst (Defense Commun. Agency) Feb. 1968 120 p refs
(Contract DCA-100-67-C-0068)
(AD-668347)

Extensive testing of the CURTS Phase II System has conclusively demonstrated that the CURTS hardware and software used by that system will have a significant impact--when used as described in the existing DCA CURTS plan--on the quality, reliability, availability, and cost effectiveness of the existing DCS HF plant. This report discusses the optimization of the proposed operational CURTS system (a system similar to the CURTS Phase II network) and the extension of that system (by frequency management

software) to provide service to other DOD, to NCS, and to international users. The report answers a key question advanced in the second final report of this series: How much improvement will be brought from a given amount of management. Further, it constitutes the study recommended in that report by detailing the method for achieving the maximation of both economic and military CURTS benefits. The current technical, managerial, and administrative problems of HF communications systems are described and are shown to limit the performance of the DCS (and other) HF systems to levels of reliability and quality that are significantly below actual system potential. With the evolution of the CURTS system, the economic value of the DOD HF system will increase, in terms of replacement systems, from a current annual value of $45 million to a final annual value of $118 million. Author (TAB)

N68-26231 University of Southern Calif., Los Angeles.
A STATISTICAL MODEL FOR RADIATION WITH APPLICATIONS TO OPTICAL COMMUNICATIONS
Sherman Karp (Ph.D. Thesis) 1967 151 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-8011

In response to an incident optical radiation, a Poisson (shot noise) process describes the induced current resulting from the photo-electric process. Under an idealized limiting condition it is shown that a Poisson process can be made to converge in probability to any continuous random function over a finite interval. When physical constraints are placed on the process, the limiting condition is analogous to having the signal-to-noise ratio approach infinity. Any finite value of signal-to-noise ratio determines the first n moments of the process which approximate the corresponding n moments of the function being represented. For large values of signal-to-noise, the equivocation appears as an additive component of Gaussian noise. Since the Poisson process is representative of the photoelectric current and is also complete in probability, the envelope of the scalar portion of the radiation is expanded in a Poisson process. This representation is generalized to allow for phase and a certain class of channel effects called statistical delays. The time-averaged power density spectrum of the process is then calculated. The photo-detector is next modeled as responding to the instantaneous power (intensity) of the radiation, where we use, for the radiation, the expansion as a Poisson process previously described. Dissert. Abstr.

N68-26251# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ARRAY ANTENNAS
T. C. Cheston and J. Frank Mar. 1968 143 p refs
(Contract NOw-62-0604-c; ARPA Order 805)
(TG-956; AD-668137)

Array antennas in their various forms are discussed and analyzed with special reference to electronic scanning. The effects of mutual coupling of the radiating elements are considered and methods of matching are given. Quantization errors, particularly those found in phased arrays, are calculated and bandwidth limitations are derived. Specific array antenna systems are described. Author (TAB)

N68-26254*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARINER MARS 1964 ANTENNA STRUCTURE DESIGN AND DEVELOPMENT
William E. Layman 15 May 1968 26 p
(Contract NAS7-100)
(NASA-CR-95098; TR-32-952) CFSTI: HC $3.00/MF $0.65
CSCL 09F

Various approaches explored in the development of lightweight Mariner Mars 1964 (Mariner IV) high-gain and low-gain antennas are discussed and key problem areas highlighted. During the development of the Mariner IV high-gain antenna reflector, various design concepts and fabrication techniques were investigated and prototypes of the various designs were built. Special problems with their solutions are discussed and some suggestions are given for future lightweight antenna development. Also highlighted are special properties of foil gage aluminum honeycomb structures and of oriented fiberglass trusses. The background of the Mariner IV low-gain antenna structure, its design requirements, constraints, and fabrication problems are described. The report emphasizes the importance of technical refinement in antenna development, the maintenance of balance between analysis and developmental testing of subassemblies, and the close coordination required between the mechanical and the electrical engineer to resolve special problems while meeting delivery schedule and performance criteria. Also discussed are procurement techniques that enhance the probability of delivering high quality hardware on schedule. Author

N68-26281 Michigan Univ., Ann Arbor.
THE THEORY OF SIGNAL DETECTABILITY: ROC CURVES AND THEIR CHARACTER
Theodore Gerald Birdsall (Ph.D. Thesis) 1966 441 p
Available from Univ. Microfilms: HC $20.05/MF $5.65 Order No. 67-8217

The first problem in the theory of signal detectability deals with the decision between two alternative responses, corresponding to two possible classes of causes of an observation. When the goal of a decision process is to achieve the highest quality of terminal decision, the Receiver Operating Characteristic curve (ROC curve) contains all of the information necessary for the evaluation of the decision process. The formal development is based on two key facts. The first is the fundamental theorem: if $l(X)$ is the likelihood ratio of an observation, then the likelihood ratio of l is l itself. The second is the main theorem on ROC characters: each ROC character is isomorphic to a univariate probability distribution that possesses a moment generating function. The character convolution theorem and the character addition theorem follow directly from these. Families of ROC curves are developed from the main theorem on ROC characters. ROC curves contain information about the performance of other two-cause decisions besides the two-response decision. Dissert. Abstr.

N68-26287# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NONSELECTIVE OPTICAL-ACOUSTIC RECEIVER WITH AN OPTICAL MICROPHONE [NESELEKTIVNYY OPTIKO-AKUSTICHESKIY PRIYEMNIKS S OPTICHESKIM MIKROFONOM]
N. A. Pankratov 16 Jun. 1967 34 p refs Transl. into ENGLISH from Optiko-Mekh. Prom. (Leningrad), no. 1, 1960 p 37-48
(FTD-MT-67-62; AD-668509)

The paper describes a non-selective optico-acoustic receiver of infrared radiation. The instrument consists of a radiation absorption chamber and an optical microphone. A diagram of the optical system is shown. An intermittent stream of radiation passes through fluorite window and is absorbed by a thin layer of aluminum applied to an extremely thin celluloid substrate, which is located in the optico-acoustic chamber. Pressure pulsations are generated by absorption of the radiation in the chamber. These pulsations cause celluloid diaphragm to oscillate. This diaphragm, which is coated with a reflecting layer of antimony, is simultaneously one of the walls of the chamber and also the diaphragm of the microphone. A transparent glass grating is located in the focal plane of lens, which is separated from diaphragm by a distance of 15 mm. An image of light source is projected through the grating onto the diaphragm by condenser lens. This image is than reflected through the second half of the grating to mirror and from there through iris to single-stage photomultiplier. The vibration of the

microphone diaphragm causes a periodic displacement of the image along the optical axis which results in oscillations of the light flux sent from the auxiliary source to the photomultiplier. Author (TAB)

N68-26298# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DESIGN STUDIES FOR 440-FOOT-DIAMETER RADIO AND RADAR TELESCOPE
Herbert G. Weiss 20 Feb. 1968 29 p refs
(Contract AF 19(628)-5167)
(ESD-TR-68-19; TR-445; AD-668474)

Studies conducted by the Cambridge Radio Observatory Committee during the past two years show that a large steerable telescope can be constructed at lower cost and with higher precision if the antenna is protected from the environment by a radome. These studies also indicate that the extremely high pointing precision (10 arc-sec) needed to make effective use of a large aperture at wavelengths as short as 5 cm can be obtained with a radome-protected antenna. The proposed 440-foot antenna employs a deflection-compensated vertical truss reflector support structure to maintain a 0.09-inch rms tolerance in the primary reflector under all operating conditions. The low cost of the antenna results from the ability to use lightweight reflector panels, an efficient computer-optimized reflector support structure, a small-diameter azimuth bearing, and a low-power control system. The estimated cost of this novel antenna design and the radome is substantially lower than the cost of alternative exposed antennas. The equivalent aperture and gain of the proposed antenna-radome system are made equal to that of a 400-foot antenna by increasing the antenna diameter by 10 percent. This report also describes the 520-foot-diameter space-frame radome and the planned electronic instrumentation and control facilities for a proposed radio and radar observatory. Author (TAB)

N68-26316# Michigan Univ., Ann Arbor. Willow Run Labs.
ANALYSIS OF PHASE-DETECTION ERROR IN MULTIPLE SENSOR CORRELATION RECEIVERS WITH HIGH SIGNAL-TO-NOISE RATIOS
Ferrell G. Stremler Mar. 1968 28 p refs
(Contract DA-28-043-AMC-00013(E); Proj. Michigan)
(Rept.-6400-153-T; ECOM-00013-153; AD-667974)

The ideal phase-detector characteristic is analyzed mathematically for an estimation of the phase difference between two stochastic input signals. High signal-to-noise conditions are assumed in order to linearize the system with respect to the noise. The effects of nonlinearity on the signal are analyzed using a series expansion and low-pass filtering on the receiver output. The mean-square error of the detector is calculated for some typical parameters. Author (TAB)

N68-26354# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CONVERSION OF MICROSECOND INTERVALS OF TIME TO DIGITAL CODE [PREOBRAZOVANIYE MIKROSEKUNDNYKH INTERVALOV VREMENI V TSIFROVOY KOD]
Ye. I. Rekhin, V. M. Lyaporov, and V. M. Pankratov 7 Jul. 1967 33 p refs Transl. into ENGLISH from Gos. Kom. Po Ispol'z. At. Energii. Dokl. (USSR), no. 99, 1964 p 1–19
(FTD-MT-24-104-67; AD-668047)

The authors discuss converters designed for measuring the time interval (transit time) between some zero time determined by the starting signal and the time when the detector records a particle. Accuracy in the measurement of such time intervals is analyzed with respect to factors which may cause nonlinearity in the converter. Converter characteristics are discussed and a block diagram of a converter is given. A brief description is given of a converter consisting of three functional circuits: phasing pulse generator, channel pulse shaper and converter. The various components which make up these sections are described and their important parameters are given. TAB

N68-26367# Dayton Univ., Ohio
INFRARED AND RAMAN VIBRATIONAL STUDY OF ETHYLBENZENE, N-PROPYLBENZENE AND TERMINAL HALOGEN-SUBSTITUTED ANALOGS, 800-50 CM Summary Technical Report, Oct. 1966–Aug. 1967
James E. Saunders Wright-Patterson AFB, Ohio AF Mater. Lab. Mar. 1968 86 p refs
(Contracts AF33(615)-3997; AF33(657)-8553)
(AFML-TR-67-292; AD-668478)

The infrared and Raman spectra of C_6H_5-$(CH_2)_n$-X, where X = H, Cl, Br, I when n = 2 and X = H, Cl, Br when n = 3, were studied in the liquid state from 800-50/cm. An attempt was made to assign the vibrations of the monosubstituted benzene ring, the far infrared deformational vibrations, and the structure-dependent halogen stretching vibrations. In the (2-haloethyl)-benzenes, two bands are assigned to the carbon-halogen vibrations, one for each isomeric form and it is concluded that the trans conformer is more stable than the gauche. In the (3-halo-propyl)-benzenes, three bands are assigned to the carbon-halogen vibrations. The identity of these conformations is discussed using the nomenclature of Shimanouchi and Mizushima. Low temperature spectra were obtained in the 800-400/cm region in the infrared and depolarization ratios were measured in the Raman bands. It was found necessary to revise the previous vibrational assignments of ethylbenzene and propose an assignment for n-propylbenzene in the region below 800/cm. Author (TAB)

N68-26369# Communication Systems, Inc., Paramus, N. J.
WIDEBAND DIGITAL MODULATION AND DETECTION TECHNIQUES FOR TROPOSCATTER Final Report, 1 Jul. 1966–15 Dec. 1967
E. Levine, F. Kupersmith, R. T. Adams, D. Sacks, and P. Grobert Mar. 1968 108 p refs
(Contract DA-28-043-AMC-02542(E))
(C&S-68-TR-2623; ECOM-02542-F; AD-669788)

A new technique was devised and implemented for optimum transmission of digital data rates up to 2.3 megabits over tactical troposcatter paths of 50 to 150 miles in the 5 GHz band. The basic approach, resulting from a study of fading and multipath propagation statistics, is a time-frequency-phase keying pattern designed to resist multipath echoes and maximize performance through coherent detection of four-phase modulation on two frequencies transmitted one at a time. Dual in-band (single antenna) diversity is provided plus optional space diversity through quadruple predetection combining. Several innovations in digital equivalents of analog circuits were used in the breadboard model which was interfaced with the ECOM experimental Hexagon-Tobyhanna link. Performance calculations predict an increase of 2 to 1 in maximum range for an error probability on the order of 0.00001 compared to orthodox FSK or binary FM using space diversity. Single antenna (in-band diversity) performance is expected to be superior to FSK with two antennas at the same distance. Laboratory tests with the ECOM troposcatter simulator indicated that the expected reduction in multipath effects is obtained and that the in-band diversity is effective. Author (TAB)

N68-26399# California Univ., Berkeley. Lawrence Radiation Lab.
A PRACTICAL APPROACH TO EMI PROBLEMS
C. Marvin Hartley 28 Feb. 1968 5 p Presented at the Noise Reduction Conf., Livermore, Calif., 5–7 Mar. 1968
(Contract W-7405-ENG-48)
(UCRL-18111; CONF-680303-1) CFSTI: HC $3.00/MF $0.65

Mysteries associated with electromagnetic interference disappear when correct procedures are used to solve noise problems. Many problems are caused by faults in the troubled equipment itself that make it sensitive to ever-present ambient noises. The first step in a practical approach toward a noise problem must include an inspection of the affected system. When extraneous noise is at fault the source is usually found in the immediate area. Author (NSA)

N68-26464*# ADCOM, Inc., Cambridge, Mass.
A HANDBOOK OF DIGITAL MODULATION AND DEMODULATION TECHNIQUES APPLICABLE TO THE EVALUATION OF THE SATURN 5 SYSTEMS
E. J. Baghdady and J. L. Tiller 5 Jan. 1968 95 p
(Contract NAS8-21078)
(NASA-CR-61407; G-90) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Based on the applicability to the evaluation and planning of Saturn 5 data links, basic data are presented on binary phase shift keyed modulation, binary frequency shift keying, and M–ary systems. Time duration and bandwidth occupancy are defined, and several pulse waveforms and their mathematical expressions and Fourier transforms are listed. Performance characteristics of each system in the presence of additive white Gaussian noise are evaluated. M.G.J.

N68-26475# Signatron, Inc., Lexington, Mass.
AN INVESTIGATION OF QUANTIZATION TECHNIQUES Final Report, 29 Nov. 1966–28 Feb. 1968
Herbert Gish Feb. 1968 53 p refs
(Contract F19628-67-C-0122)
(SIG-CR-337; AFCRL-68-0150; AD-669097)

The report consists of two parts, each developing a different approach to the efficient quantization of analog sources. In Part I, it is shown, under weak assumptions on the density function of a random variable, and under weak assumptions on the error criterion, that uniform quantizing yields an output entropy which asymptotically is smaller than that for any other quantizer, independent of the density function or the error criterion. The asymptotic behavior of the rate distortion function is determined for the class of nuth law loss functions and the entropy of the uniform quantizer is compared with the rate distortion function for this class of loss functions. The extension of these results to the quantizing of sequences is also given. It is shown that the discrepancy between the entropy of the uniform quantizer and the rate distortion function apparently lies with the inability of the optimal quantizing shapes to cover large dimensional spaces without overlap. A comparison of the entropies of the uniform quantizer and of the minimum-alphabet quantizer is also given. In Part II, predictive quantization systems and their optimality properties are discussed. A technique for the estimation of the performance of such systems is presented which is then compared to the results of a digital simulation. Author (TAB)

N68-26498*# ADCOM, Inc., Cambridge, Mass.
RETRODIRECTIVE TRANSPONDER FEASIBILITY EXPERIMENT
Howard C. Salwen, Leslie Klein, Jerald F. Annese, and George R. Hicks, Jr. Oct. 1967 30 p refs
(Contract NAS8-21078)
(NASA-CR-61406; G-90) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A test program was conducted to verify the practical feasibility of the digital phase measuring subsystem of the pulse-coherent retrodirective transponder. Details are given on the experimental test bed incorporating the digital phase meter, pulse generating and phase shifting circuitry, IF circuitry, gray to natural code converter, D/A converter, and provision for addition of noise in the reference and signal channels independently. The time sequence of events involved in making a digital phase measurement on a single pulse is described. Repetition rates as high as 5×10^4 pulses/second are allowed for in the design to account for random access by non-overlapping interrogators. Experimental results showing the rms phase error vs input signal to noise ratio (SNR) for each setting of the variable phase shifter are depicted. It was found that the performance of the system for SNRs greater than 13 dB is adequate in all cases, and in most cases rms phase errors no greater than 45° are obtained for SNRs of 4 dB. It is pointed out that in some of the cases the quantization error, 22 1/2°, must dominate for intermediate SNRs. M.G.J.

N68-26513 Pennsylvania Univ., Philadelphia.
AN ANTI-JAM COMMUNICATION TECHNIQUE BASED ON FREQUENCY HOPPING
Max Szulim Feryszka (Ph.D. Thesis) 1966 148 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-7835

This dissertation deals with anti-jam communication systems, operating intermittently in a hostile environment and with a limited contact time. It is assumed that the jammer has available a given average power "N" which may be many orders of magnitude greater than communicator's average power "S." Additionally, it is assumed that the jammer utilizes the available power in an optimal way to maximize the probability of error. The basic technique used by communicators is based on utilization of large transmission bandwidth ($WT >> 1$) to compensate for low signal-to-jammer power ratio. It is the purpose of this study to investigate the possibility of synthesizing an anti-jam communication system which meets the requirements of (1) exponential exchange of bandwidth for probability of error; and (2) time lost for synchronization acquisition being a small fraction of the contact time. Dissert. Abstr.

N68-26589# Rydbeck Research Associates, Fjaras (Sweden).
PROPAGATION OF LOW AND HIGH POWER RADIO WAVES IN IONIZED MEDIA Final Scientific Report, 1 Apr. 1965–31 Aug. 1967
O. E. H. Rydbeck et al 31 Aug. 1967 78 p refs
(Contract AF 61(052)-864)
(AFCRL-68-0077; AS-668457)

The report covers investigations and research concerning the following main subjects, viz., Amplification properties and self oscillations of pumped, ionized media, Basic properties of coupled wave equations with variable coefficients, Energy flow properties of electromagnetic and of general multi-mode media, Coupled waves in magneto-ionic media, Coupled waves in ionized media with streaming electrons, Wave propagation in a double hump, isotropic, ionized medium, Transient wave response of an inhomogeneous, isotropic, ionized medium, D:o in a homogeneous magneto-ionic medium (longitudinal propagation). Author (TAB)

N68-26599# Institute for Defense Analyses, Washington, D. C. Science and Technology Div.
A TEST OF THE EFFECTIVENESS OF COMMAND LANGUAGE
Charles M. Mottley and Thomas G. Belden Feb. 1967 82 p
(Contract DAHC15-67-C-0011)
(N-489; AD-668970)

One of the important functions of a command and control system is the ability of the recipients of messages to recognize and categorize the different types. This ability was investigated experimentally. One of the conclusions of this study was that the performance of the subjects could be significantly enhanced by giving them a brief period of instruction in coherent language. Author (TAB)

N68-26621*# Andrew Corp., Chicago, Ill.
THE DIELECTRIC CLAD AXIAL SLOT ANTENNA
C. M. Knop, J. J. Meier, and O. K. Kim Washington NASA Jun. 1968 201 p refs
(Contract NAS1-6242)
(NASA-CR-1057) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The input admittance of a rectangular waveguide whose opening forms an axial slot on a metal cylinder of outer radius, a, which is coated with a concentric layer of homogeneous dielectric of outer radius, b, and of relative dielectric constant, ϵ_r, is analyzed. The analysis is accomplished by relating this input admittance to the external admittance by equating the complex power flow on each side of the slot. The external admittance is found by expanding the fields in the exterior of the cylinder in the form of a Fourier mode expansion following Wait, and casting the expression for the integration of Poynting's vector over the physical space of the slot into one over mode space via Parseval's theorem. The slot width is made small enough so that the higher order modes produced at the slot in the waveguide due to the slot-cylinder transition are negligible. Additionally, the guide is dielectric loaded, so as to realize sufficiently high attenuation at the slot location of the higher order modes produced at the excitation point for a given length of guide. Author

N68-26668# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SHORT-TERM OSCILLATOR STABILITY SPECIFICATIONS FOR PHASE-LOCKED LOOPS
Thomas S. Seay 29 Apr. 1968 23 p refs
(Contract AF 19(628)-5167)
(ESD-TR-68-81; TN-1968-5; AD-669090)

The specification of short-term oscillator stability for a phase-locked loop is treated. Measurements are described which will assure the desired performance. The relationship to the conventional fractional frequency deviation specification is included. Author (TAB)

N68-26672*# Maryland Univ., College Park. Dept. of Electrical Engineering.
ADAPTIVE TELEMETRY SYSTEMS Final Report
23 Apr. 1968 30 p refs
(Grant NGR-21-002-113)
(NASA-CR-94917) CFSTI: HC $3.00/MF $0.65 CSCL 17B

In most space communication systems the energy available to the spacecraft is limited. This paper is an effort to reduce the energy required by the spacecraft for a given overall probability of error by employing feedback from the ground station to the spacecraft. Three memoryless systems employing feedback are compared with a memoryless system without feedback and it is shown that for the same energy level, feedback improves the performance of a system as far as the overall probability of error is concerned. The signals considered are orthogonal, phase-coherent, and perturbed by white Gaussian noise. The conclusions, however, could be extended to non-phase-coherent signals and also Rayleigh noise. Author

N68-26682# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TOWARDS A THEORY OF THE SYNTHESIS OF ANTENNAS WITH VOLUMETRIC DISTRIBUTION OF SOURCES [K TEORII SINTEZA ANTENN S OB'YEMNYM RASPREDELENIYEM ISTOCHNIKOV]
V. N. Dymskiy 4 Aug. 1967 34 p refs Transl. into ENGLISH from Tr. Kazansk. Aviats. Inst. (Kazan), no. 82, 1964 p 3–26
(FTD-MT-24-113-67; AD-668158)

A problem is considered of calculating the directional pattern on the basis of a continuous distribution of spatial density of external currents specified in a bounded region. The problem is reduced to constructing the vector eigen-functions of an integral operator defined on a sphere. It is proven that the operator is self-adjoint, bounded, and continuous for any finite volume of current distribution. The conditions are determined of an optimal solution which corresponds to the maximum ratio of radiated power to the external current norm. A rigorous solution of the problem, for the radiating regions that have a spherical-layer and spheroid-layer shapes, is presented as an illustration. TAB

N68-26688# Aerospace Corp., El Segundo, Calif. Lab. Operations.
CLUTTER SUPPRESSION PROPERTIES OF WEIGHTED PULSE TRAINS, JUNE–DECEMBER 1967
Richard L. Mitchell and August W. Rihaczek Feb. 1968 35 p refs
(Contract F04695-67-C-0158)
(TR-0158(3230-46)-9; SAMSO-TR-68-142; AD-668441)

A common but troublesome requirement on radar sensors is the detection of a target in the interference from undesired scatterers, or clutter. Systems with coherent processing of pulse trains are uniquely suited for the purpose because with pulse trains it is possible to concentrate the receiver output for particular values of Doppler and thus suppress the clutter by Doppler filtering. This paper discusses to what degree the effectiveness of the method can be enhanced by tapering, or weighting, of the pulse amplitudes. The general results are illustrated by computer-plotted response functions for weighted pulse trains. The clutter suppression efficiency of weighting is calculated both for unilateral weighting in the receiver and for bilateral weighting is discussed, and the results for pure amplitude weighting are compared with published work on phase and amplitude weighting. Author (TAB)

N68-26707*# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
REVIEW OF THE THEORY OF THOMSON SCATTER
D. T. Farley (Radio Observatorio de Jicamarca, Lima, Peru) [1967] 12 p refs Presented at the Conf. on Thomson Scattering, Illinois Univ., 10–12 Apr. 1967
(NASA Order-R-06-012-008)
(NASA-CR-85738) CSCL 17I

The theoretical conclusions and predictions that seem to be most relevant to the Thomson scattering observations presently being performed or contemplated, are reviewed. The physical processes controlling the scattering are discussed, and through qualitative arguments, it is shown that all the detailed results of the full theory are quite plausible. Author

N68-26716# Illinois Univ., Urbana. Coordinated Science Lab.
COMMUNICATION NETWORKS WITH SPECIFIED SURVIVABILITY
David Eugene Butler Jul. 1967 40 p
(Contract DA-28-043-AMC-00073(E))
(R-359; AD-656451)

The paper considers the problem of the survivability of communication networks from the point of view of graph theory. Stations are represented by nodes of a graph and communication links between stations are represented by edges of a graph. The strength of a graph is defined with respect to nodes only, and both nodes and edges. Two methods of constructing graphs with specified strength are derived. Planar graphs are studied and a bound on their strength is found. Methods of finding the strength of an arbitrary graph are given. Author (TAB)

N68-26734# Florida Univ., Gainesville. Communication Sciences Lab.
UNDERWATER SPEECH COMMUNICATION: ABSTRACTS OF FOUR STUDIES IN UNDERWATER COMMUNICATION Interim Progress Report

Harry Hollien, John F. Brandt, and James Malone 1 Mar. 1968 13 p
(Contract Nonr-580(20))
(CSL/ONR-20; AD-668976)

Abstract reports of the following four experiments are presented: (1) Speech Intelligibility as a Function of Helium-Oxygen Breathing Mixtures; (2) Speech Intelligibility in High Ambient Pressures; (3) Intelligibility of Filtered Underwater Speech in Quiet and Noise; (4) Intelligibility Underwater of Different Speech Modes. TAB

N68-26745# Illinois Univ., Urbana. Coordinated Science Lab.
A STUDY OF NORDSTROM-ROBINSON OPTIMUM CODE
Franco P. Preparata Apr. 1968 21 p refs
(Contract DAAB07-67-C-0199; Grant NSF GK-2339)
(R-375; AD-668485)

The optimum quadratic (15,8) code with minimum distance d =5, recently discovered and studied by Nordstrom and Robinson, can be rather naturally described in terms of polynomials over GF(2). It is shown that the Nordstrom-Robinson code consists of a linear code and of a certain subset of its cosets, which account for its non-linear nature. This representation leads to a non-heuristic proof that weight and distance structures can be treated analogously and that the minimum distance and weight are 5. The analysis of this mechanism may be an essential step in the discovery of an entire class of non-linear double error correcting codes. The given analysis also suggests a systematic decoding procedure. This is based on permutations which map any correctable error pattern (double or single errors) into digit positions for which the computation of a syndrome allows the correction. The correct code word can then be recovered through the inverse permutation. Author (TAB)

N68-26778# RAND Corp., Santa Monica, Calif.
THE APPLICATION OF BOSE-CHAUDHURI CODES TO THE CONSTRUCTION OF BURST-ERROR-CORRECTING CODES
Alan J. Gross Apr. 1968 47 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5562-PR; AD-668419)

A study showing that if Bose-Chaudhuri type parity check matrices are augmented by one or two columns, the corresponding codes--constructed by means of Galois fields--not only can correct a predetermined number of independent errors but also can correct bursts of errors that may occur in message transmission. In using such codes, it is necessary to add redundancy to the code messages, that is, to add check places to the original message that do not give any additional information. Thus redundancy is the price for sending a correct message, and the question then becomes one of how to obtain codes having a minimum amount of redundancy for a given message length, and still ensure that although a transmitted message may contain one or more bursts of errors, it will still be decoded correctly. These codes are extensions of the Bose-Chaudhuri codes, dealing with independent error correction. Author (TAB)

N68-26864# Aeronautical Chart and Information Center, St. Louis, Mo.
BERMUDA ADJUSTMENT AND RADAR CALIBRATION PROJECTS (AF 65-RAD 1-4) (AF 67-12 ESD)
Donovan N. Huber and William L. Gleiber Jan. 1968 23 p ref
(ACIC-TR-106; AD-668431)

The addition of the chopping shutter has greatly expanded the Air Force geodetic capability through observation of passive satellites. The Mod III, Rapidyne, external chopping shutter and the GDI-5 internal equipment both became operational early in 1966. Four Mod IIIs and PC-1000 cameras were deployed in October to sites along the United States Coast and Geodetic Survey (USC and GS) Precise Traverse on the East Coast and at Grand Forks, N.D. and Bermuda to collect data for two radar calibration projects and triangulation adjustments. One other PC-1000, with a GDI-5 internal shutter was located at Bedford, Mass. principally for radar calibration. Simultaneous observations were fabricated through precise timing records. The reduced data reached an internal consistency of 1/1,000,000 and datum shifts derived for the Bermuda local datum differed by only 20 feet from shifts determined by the USC and GS with BC-4 data. In addition to the accuracies achieved, more data can be obtained in the same period of time observing passive satellites. Other projects are in work and planned for further use of the Mod III optical system. Author (TAB)

N68-26867# Naval Civil Engineering Lab., Port Hueneme, Calif.
EXPERIMENTAL FM MULTIPLEXING TRANSPONDER SYSTEM FOR REMOTE RADIO CONTROL AND TELEMETERING Final Report, 1 Jul. 1966-27 Jul. 1967
S. J. Wooten, L. J. Elliott, and S. L. Phelps Apr. 1968 48 p ref
(R-574; AD-669114) CFSTI: HC $3.00/MF $0.65

An experimental FM multiplexing transponder system was designed to trigger the ventilation closure valves of protective shelters as soon as the overpressure produced by a nuclear blast is detected by a pressure transducer. The system would provide complete protection for shelters located 12,000 feet or more from the target. The system consists of five FM multiplexing transponders transmitting five channels of FM data to the central receiver, one channel at a time, with each transponder initiating the next transponder transmission. Only one carrier frequency is used regardless of the number of transmitters; also, since the transponders transmit data only on interrogation, battery life is greatly increased. The flexibility of this battery powered system, its ability to accept a wide variety of emergency inputs, its fail-safe design, and its low cost make it suitable for a wide variety of data transmission applications. Author (TAB)

N68-26915# Michigan Univ., Ann Arbor.
A 201A DATA COMMUNICATION ADAPTOR FOR THE PDP-8: PRELIMINARY ENGINEERING DESIGN REPORT
David E. Wood Feb. 1968 155 p *Its* Memo. No. 15
(Contract DA-49-083-OSA-3050; ARPA Order 716)
(AD-668384)

This report discusses the design and use of equipment built for data communication to and from a PDP-8 through a 201A data set. The purpose of the data communication interface is to allow a PDP-8 to send and receive digital data through a 201A data set in half-duplex mode. Basic design objectives and decisions are described first. A brief overall system description together with a sketch of a data format scheme and programming considerations is followed by a detailed description of the interface logic. Author (TAB)

N68-26954# Innsbruck Univ. (Austria)
FREQUENCY DEPENDENCE OF THE FIELD STRENGTH COMPONENTS OF A DIPOLE EMBEDDED IN A CONDUCTING MEDIUM Scientific Report, Aug.-Sep. 1967
G. Tinhofer 30 Nov. 1967 16 p refs
(Contract AF 61(052)-902)
(AFCRL-68-0174; SR-5; AD-668518)

In present report, the field structure of dipole transmitters is examined as dependent on the working frequency. At given technical possibilities and under the condition that the electrical parameters of a homogeneous medium are independent of the frequency, there exists an optimum working frequency for the transversal field component of a magnetic dipole. Given technical possibilities mean that the dipole moment at the transmitter side can be kept constant in the frequency region under consideration, and that the

sensitivity available on the receiver side is the same for any frequency. The optimum frequency at typical experimental values of conductivity and dielectric constant lies at 100 kcps. This behavior of field strengths is the same also in the case of an electrical dipole, when considered qualitatively. Author (TAB)

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N68-25671# Argonne National Lab., Ill. Applied Mathematics Div.

A MOESSBAUER-EFFECT DATA-COLLECTION SYSTEM

R. H. Vonderohe and R. A. Aschenbrenner Nov. 1967 18 p

(ANL-7386) CFSTI: HC $3.00/MF $0.65

A system is described which has several advantages over running the same number of experiments, each with a dedicated analyzer. First, the cost of the computer system is approximately 30% less than the cost of four analyzers. In spite of this price differential, there is no loss of versatility to the experimenter (assuming, of course, there is no catastrophic failure). In fact, the computer system offers a great deal more versatility, particularly in the area of data preprocessing. It is now possible to do such things as channel summations, spectra folding, and exact peak center determinations, which were previously unrealizable with analyzers. In addition, the energy calculations that previously required additional computing power may now be performed. Another advantage of this system is the capability of outputting an experiment and reloading the same experiment at a later time for additional data storage. In short, the system has all the advantages of a general-purpose digital computer in addition to performing the tasks of a wired-program analyzer. Author (NSA)

N68-25709# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.

TERMTRAN: A PROGRAMMING SYSTEM FOR ENGINEERING CALCULATIONS VIA REMOTE TERMINALS

G. B. Knight and R. E. Neu 23 Feb. 1968 53 p refs

(Contract W-7405-ENG-26)

(K-1735) CFSTI: HC $ 3.00/MF $0.65

A programming system for performing a variety of engineering and scientific calculations using a remote terminal is described. The system is designed to be fast, economical and easy-to-learn yet still offer the basic essentials of a programming language. The unique feature of the system is its ability to function in a multi-programming environment (OS/360) while offering a minimum of interference to other executing tasks. The system has been implemented on the IBM 360/50 and has performed very satisfactorily to date. It is available to any user who has access to the Computing Technology Center's teleprocessing network. Author (NSA)

N68-25711# Union Carbide Nuclear Co., Oak Ridge, Tenn. Scientific Applications Dept.

THE PROGRAMMER'S HANDBOOK: A COMPENDIUM OF NUMERICAL ANALYSIS UTILITY PROGRAMS

R. E. Funderlic, ed. 9 Feb. 1968 299 p refs

(Contract W-7405-ENG-26)

(K-1729) CFSTI: HC $3.00/MF $0.65

A compendium of numerical analysis utility programs is presented. Emphasis was placed on ease of usage, and every effort was made to provide comments on the theory behind each routine, theoretical and practical limitations, and coding information. NSA

N68-25743*# Stanford Univ., Calif. Instrumentation Research Lab.

A MASS SPECTROMETER DATA ACQUISITION AND ANALYSIS SYSTEM

Robert B. Tucker 28 Mar. 1968 42 p refs

(Grants NsG-81; NIH-FR-00151; PHS-NB-04270)

(NASA-CR-94919; IRL-1063) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A data acquisition and analysis system for a low resolution mass spectrometer is described that utilizes a small digital computer to acquire, interpret, and plot the mass spectra. The data can be stored on magnetic tape for later reference. Provisions also exist for sending the data to larger computers for further analysis. Emphasis has been placed on a high degree of user-computer interaction. A teletypewriter, display screen, and a digital plotter are used for ease of communication between the user and the computer. Author

N68-25783*# Catholic Univ. of America, Washington, D. C.

RELATIVE PHASE DIFFERENCE ANALYSIS PROGRAM

D. M. Koenig *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.–Catholic Univ.–NASA Summer Fac. Fellowship Program Apr. 1968 p 77–103 refs (See N68-25779 15-07)

The strip chart recording of oscillator-pair data, which is relative phase difference, is described, and a detailed description of the procedures for the subprograms is given. These routines cover data corrector, subtraction of mean temperature, polynomial fitting, Gauss–Jordan reduction, calculation of error at each point, rejection of bad points, and autocorrelation of the residuals to show the presence of any periodic behavior. M.G.J.

N68-25785*# Miami Univ., Oxford, Ohio.

COMPUTER SYSTEMS FOR REAL-TIME APPLICATIONS

David F. Nyman *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.–Catholic Univ.–NASA Summer Fac. Fellowship Program Apr. 1968 p 105–121 refs (See N68-25779 15-07)

The hardware and software capabilities of the Sigma 5 computer are discussed from the viewpoint of developing a real-time control system for tracking station automation. Consideration is given to the general problems involved in multiprogramming, interrupt control features, memory protection, relocation of programs, and provision for internal timers. In this context, the Sigma 5 computer is described to show the design features incorporated to meet real-time system requirements. These include multiplexor input–output processor(s); two core memory modules, each with 16,000 words of memory; internal and external interrupts; and a series of registers for centralizing computer control. Also discussed are monitor programs which normally consist of five major sections: supervisor, translators, the load routine, the foreman, and the input–output control system (IOCS). The batch monitor for the Sigma 5 is to have a 4,000 word resident core load, with the supervisor, translator, IOCS, and loader sections provided. However, the real-time foreman control will have to be written by the user. M.G.J.

N68-26062*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

A LIMITED SPEECH RECOGNITION SYSTEM Final Report

Daniel G. Bobrow and Dennis H. Klatt 15 May 1968 78 p refs

(Contract NAS12-138)

(NASA-CR-86058; BBN-1667) CFSTI: HC $3.00/MF $0.65 CSCL 09B

LISPER, a program designed for limited speech recognition, learns to identify utterances as one of a limited input message set. Functions of the raw spectral data are transformed into sequences of states (features) in order to normalize for word onset time, speaking rate, and speaking rhythm. State transition thresholds are normalized for speaking level, and a hysteresis region is employed about decision thresholds to reduce the sensitivity of the system to noise. A feature sequence need not be consistently correct

because the recognition algorithm makes use of redundancy to identify the most probable message. Features related to tense-lax, sibilant, fricative, continuant, several place-of-articulation features and a stress feature are included in a set of "linguistic" features used for recognition. Another set of non-linguistic features was also tested. Recognition scores approach 97% correct after three rounds of training of a 54 word vocabulary for both sets of features. Author

N68-26192 Cornell Univ., Ithaca, N. Y.
AN ITERATIVELY STRUCTURED DIGITAL COMPUTER
Joel Nathaniel Sturman (Ph.D. Thesis) 1966 198 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-1415

This work is an investigation of a general-purpose digital computer composed entirely of small sequential machines. The sequential machines, or cells, are identical in structure, each cell having fewer than 2^{11} states. The one-dimensional iterative array of cells which constitute this computer is similar to the distributed logic associative memory originally proposed by C. Y. Lee. Sufficient logic must be incorporated into this iterative array to store and interpret instructions, to find and perform arithmetic and other manipulative operations on the data stored elsewhere in the array, and to perform the sequencing and branching of instruction control as performed in a more conventionally structured computer. No specific area of this machine acts solely as a memory, an arithmetic unit or a control unit; but rather one or more cells within the iterative array perform all of the above tasks. The logical structure of a typical cell is described, and programming techniques peculiar to this machine are investigated. Dissert. Abstr.

N68-26286# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ALGORITHM OF THE SELECTION OF CONCEPTS WITH THE HELP OF A SYNTACTIC TABLE [ALGORGTHM VYDELENIYA PONYATIY S POMOSHCH'YU SINTAKSICHESKOY TABLITSY]
Ye. A. Zhogolev 9 Jun. 1967 22 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat i Mat. Fiz. (Moscow), v. 5, no. 4, 1965 p 689–698
(FTD-MT-67-76; AD-668030)

The method of machine translation described in this article concerns the principles of organization in algorithmic language (in this case in the (ALGOL-60)) and are calculated basically for small machines. However, they can be used in multipass translators. It is natural in the structure of the translator to separate the part realizing the syntax of the language and the part realizing its sematics. In connection with this there was selected the following structure of the translator: (a) the syntax of the language is assigned a special syntactic table; (b) the semantics of the language is assigned a library of subprograms such as each syntactic unit of the language (metavariable) corresponds to its semantic subprogram; (c) the operation of the translator is ensured by a certain control program, which consecutively (one by one) selects the basic symbols of the language from the recording of the algorithm, turns their sequences, according to the syntactic table into increasingly enveloping syntactic units and with the selection of each unit turns to the corresponding semantic subprogram; in other words, in a given control program the algorithm of the selection of concepts is realized. Author (TAB)

N68-26292*# Auerbach Corp., Philadelphia, Pa.
DATA MANAGEMENT SYSTEM STUDY Final Technical Report, 15 May 1967–31 Mar. 1968
Jerome D. Sable and James Cochrane 1 Apr. 1968 289 p refs
(Contract NAS12-562)
(NASA-CR-86057; Rept.-1469-TR-4) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The data processing needs of NASA post-Apollo missions are examined, with attention focused on (1) a job management system (command language and job control), (2) internal file system (data definition language, directory structure, and logical data services), and (3) external file system (secondary storage management and physical data services). Data management system features are characterized, current and proposed systems are evaluated, and system concepts are developed. Elements of an interactive system servicing an on-going data base for a community of users are identified as an input string handler and corrector, a basic time-slicing mechanism and monitor, a job management system, a file system, a set of language processing subsystems, and a set of system services. A coherent system concept is proposed which, in addition to possessing program coherence through the dynamic use of system commands, has the ability to define, name, and store program structures so that they may be easily and repeatedly invoked by the user. It is believed that the prototype coherent system specified can be developed for use in an interactive real-time environment. M.G.J.

N68-26371# Adams (Charles W.) Associates, Inc., Bedford, Mass.
DEVELOPMENT OF HIERARCHICAL GRAPHICAL LOGICAL ENTITY CAPABILITIES: TIME-SHARING INPUT-OUTPUT EXECUTIVE (10X) PROGRAMMER'S MANUAL, PART 3 Final Report, Apr. 1965–Jan. 1968
Edward N. Chase and David A. Westlake 15 Feb. 1968 97 p
(Contract AF 19(628)-5098)
(AFCRL-68-0131; AD-668427)

A special-purpose time-sharing executive program for the PDP-1 computer is described. Input-output transfers, multiple-user operation, inter-user communication and inter-module transfers are interpreted and performed by the executive program. Although the program reflects the hardware configuration of the Dynamic Experimental Processor (DX-1), the techniques used are applicable to other similarly-configured computer systems. Author (TAB)

N68-26372# Adams (Charles W.) Associates, Inc., Bedford, Mass.
DEVELOPMENT OF HIERARCHICAL GRAPHICAL LOGICAL ENTITY CAPABILITIES: DISPLAY SYSTEM OPERATOR'S MANUAL, PART 1 Final Report, Apr. 1965–Jan. 1968
Edward N. Chase and David A. Westlake 15 Feb. 1968 85 p ref
(Contract AF 19(628)-5098)
(AFCRL 68-0130; AD-668425)

Developed as a general-purpose program for the computer entry and manipulation of hierarchically-structured graphical information, the DX-1 Display System utilizes a drum-buffered scope, light pen and pushbutton box to provide the console user with the ability to draw charts, diagrams, curves, etc., on the face of the display scope. The drawings contain information which is reduced to a condensed digital format called an Entity Table. This table can then be manipulated by the use of special-purpose software during the drawing action. Graphical information generated by either console user or a conversational-mode computational program can also be displayed in full color. Author (TAB)

N68-26375# Adams (Charles W.) Associates, Inc., Bedford, Mass.
DEVELOPMENT OF HIERARCHICAL GRAPHICAL LOGICAL ENTITY CAPABILITIES: DISPLAY SYSTEM PROGRAM MANUAL, PART 4 Final Report, Apr. 1965–Jan. 1968
Edward N. Chase and David A. Westlake 15 Feb. 1968 303 p refs
(Contract AF 19(628)-5098)
(AFCRL-68-0129; AD-668428)

The programs of the DX-1 Display System are documented. Descriptions include program functions, calling and exiting sequences, common storage registers, logic of operation, and program listings. Author (TAB)

N68-26376# RAND Corp., Santa Monica, Calif.
COMPUTERS AND INFORMATION FLOW
R. L. Patrick Mar. 1968 18 p
(P-2791-1; AD-668417)

The purpose is to provide a general introduction to the field, to pin down its unique terminology and jargon, to identify the various types of computers and the scope of computational capabilities, and to provide some rules of thumb which can be applied in determining whether a need for such a capability exists or not. Author (TAB)

N68-26378# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
ONE-LINE RANDOM NUMBER GENERATORS AND THEIR USE IN COMBINATIONS
George Marsaglia and T. A. Bray Mar. 1968 12 p refs *Its* Mathematical Note No. 551
(D1-82-0689; AD-667956)

This is a discussion of some one-line random number generators, requiring a single FORTRAN instruction, together with a description of some short FORTRAN programs which mix several such generators. Evidence suggesting that the simple congruential generators are unsatisfactory continues to grow; one of the most promising alternatives is to mix several simple generators. These composite generators do better in various tests for randomness than do the simple congruential generators used at many computer centers. TAB

N68-26417# Catholic Univ. of America, Washington, D. C.
ELEMENT DEVELOPMENT FOR ADVANCED ASSOCIATIVE MEMORIES Final Report, Mar. 1966–Jan. 1968
Charles F. Pulvari, Noemi Szabo, Melvin J. Walsh, Jr., Antonio De La Paz, William B. Penzes et al Griffiss AFB, N. Y. RADC Apr. 1968 137 p refs
(Contract AF 30(602)-3717)
(RADC-TR-68-105; AD-668473)

The objective of this research was to demonstrate that capacitor elements comprising the mixed bismuth oxide type ferrielectrics as a dielectric represent an important improvement as compared to ordinary ferroelectric capacitors and they can be utilized as logic and memory devices. Author (TAB)

N68-26429# Adams (Charles W.) Associates, Inc., Bedford, Mass.
DEVELOPMENT OF HIERARCHICAL GRAPHICAL LOGICAL ENTITY CAPABILITIES: ENTITY TABLE DESIGN, PART 2 Final Report, Apr. 1965–Jan. 1968
Edward N. Chase and David A. Westlake 15 Feb. 1968 38 p
(Contract AF 19(628)-5098)
(AFCRL-68-0128; AD-668426)

A multilevel graphical data structure for an 18-bit digital computer is described. Graphical entities defined by the data structure may be linked together by a ring structure, logically tied coordinates, or other independent parameters. The structure is ideally suited for use with a large, delayed-access, mass-storage device, as the displayed picture representing the graphical entities can be generated independently of their logical linking. Author (TAB)

N68-26430# George Washington Univ., Washington, D. C.
BOUNDS FOR MAXIMAL TEMPORALLY REPEATED FLOWS IN A NETWORK
Donald J. Hunt and W. L. Wilkinson 19 Mar. 1968 90 p refs
(Contract N00014-67-A-0214)
(AD-668174)

This paper is addressed to the capacitated transshipment problem. A Push/Pull Algorithm is described which is a variation of the Ford and Fulkerson Algorithm. Both algorithms solve either the minimal cost flow or maximal dynamic flow problem. A supplementary procedure, a Bounded Flow Algorithm, employs the Push/Pull Algorithm to determine the arc flow bounds for alternative optimal solutions. A theorem is offered concerning these bounds. The logic for the computer programs is described together with some observations on computing efficiency with network algorithms. The paper concludes with a network example and numerical results. Author (TAB)

N68-26496# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANALOG DIGITAL MULTIPLIER WITH EXPANDED RANGE OF CODE FACTOR CHANGE [ANALOGO-TSIFROVOYE MNOZHITEL'NOYE USTROYSTVO S RASSHIRENNYM DIAPAZONOM IZMENENIYA KODOVOGO SOMNOZHITELYA]
T. F. Bekmuratov and V. P. Skuridin 7 Jul. 1967 13 p ref Transl. into ENGLISH from Izv. Akad. Nauk Uz. SSR, Ser. Tekhn. Nauk (Tashkent), no. 4, 1966 p 27–30
(FTD-MT-24-140-67; AD-668058)

An analog-digital multiplier is presented. The factors to be multiplied are: (1) a binary coded quantity entered into the register and (2) a voltage level between 0 and 10 v. The product is given with an accuracy of plus or minus 0.2% at the 10-bit counter output. TAB

N68-26515# Illinois Univ., Urbana
[DEPARTMENT OF COMPUTER SCIENCE] Quarterly Technical Progress Report, Oct.–Dec. 1967
W. J. Poppelbaum Dec. 1967 276 p
(Contract Nonr-1834(15))
(AD-668321)

Contents: Circuit research program; Hardware systems research; Software systems research program; Illinois pattern recognition computer (Illiac III); Illiac IV; Numerical methods, computer arithmetic and artificial languages; Computational physics; Switching theory and logical design; Illiac II service, use, and program development; IBM 7094/1401 service, use, and program development; Problem specifications; and General department information. TAB

N68-26524# Army Electronics Labs., Fort Monmouth, N. J.
MEMORY ELEMENT FLIP-FLOP INPUT EQUATIONS
David Haratz Dec. 1967 32 p refs
(ECOM-2927; AD-667903)

A graphical method is described that is generally useful for solving a pair of simultaneous Boolean equations, particularly the system application equation and memory characteristic equation for determining the memory element flip-flop input equations. The decision mechanism utilized for determining the Karnaugh map structure from which an optimum solution may be obtained is based totally on the behavioral characteristics of the memory element as derived from a truth table. Simple illustrative examples are included for the R-S flip-flop (with variations in dominance), the J-K flip-flop and the R-S-T flip-flop encompassing various classes of don't care conditions. Author (TAB)

N68-26527# Burroughs Corp., Paoli, Pa. Defense, Space and Special Systems Group.
PARALLELISM IN COMPUTER PROGRAMS AND IN MACHINES Quarterly Technical Report, 21 Oct. 1967–26 Jan. 1968

Harvey W. Bingham and Earl W. Reigel Apr. 1968 32 p refs
(Contract DA-28-043-AMC-02463(E))
(ECOM-02463; TR-68-1; QTR-6; AD-667907)

A second method for partial order control using the results of the previously reported parallelism detection algorithm is given. A comparison in cost of representation and use is made among the two order control methods and sequential control. Parallelism among executions of loop bodies and among nested and interlocked loops is examined. A system design for parallelism exploitation is described. This system uses a block oriented random access memory (BORAM) for secondary storage to minimize access time. Some characteristics of dynamic sequencing procedures for selection among ready tasks are given. Author (TAB)

N68-26536# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPECIALIZED CALCULATING MACHINES FOR CALCULATION OF ECONOMIC DISTRIBUTION OF ACTIVE LOADS IN POWER SYSTEMS [SPETSIALIZIROVANNYYE VYCHISLITEL'NYYE MASHINY DLYA RASCHETA EKONOMICHNOGO RASPREDELENIYA AKTIVNYKH NAGRUZOK V ENERGOSISTEMAKH]
S. A. Ginzburg, A. N. Stavrovskiy, and V. D. Shlimovich 27 Oct. 1967 18 p refs Transl. into ENGLISH from Elektrichestvo (Moscow), no. 7, 1966 p 85–89
(FTD-MT-24-316-67; AD-668183)

Based on 1957–65 Soviet, 1955–62 Western, and 1959–64 Japanese literature, a review is presented which covers the following points: Scope of problems and type (mostly analog) of computer. Representation of incremental-rate characteristics of plants. Allowance for network losses. Uses of special-purpose computers and economic efficiency: (a) prediction of load diagrams, (b) counseling the dispatcher, and (c) automatic control. Data on uses of special-purpose computers in the following power systems is presented: Estonian Power System; Sverdlovsk, Chelyabinsk, Bashkir ASSR, Donbass Power Systems; Ural Joint Dispatching System; European-SSSR Joint Dispatching System; Altay Power System; Georgian SSR Power System; West-Siberian Joint Dispatching System; Hungarian Joint Dispatching System; S. California, Edison Co.; West Penna.; Ohio Edison Co.; Colorado Public Service Co.; unnamed Soviet Power System; Kusu, Tubu, Japanese System; Tugoku, Tokyo System. TAB

N68-26585# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
COMBINED CALCULATING DEVICE [KOMBINIROVANNAYA VYCHISLITEL'NAYA USTANOVKA]
G. K. Krug, I. A. Sirmay, N. I. Chelnokov, and I. L. Tsvetayeva 13 Sep. 1967 11 p Transl. into ENGLISH of the book "Vychislitelnaya Tekhnika v Upravlenii" Moscow, Izd-Vo Nauka, 1966 p 152–157
(FTD-MT-24-240-67; AD-668055)

It is noted that the computing capabilities of a combination of a digital computer and an analog computer connected by a communications unit considerably exceed the capabilities of the digital and analog devices taken separately. This combination is especially valuable for small computer centers which include one or two Ural-type limited speed digital computers or a Minsk and several MN-7 type or MNB analog computers. It is reported that the Problems Laboratory of Automation and Telemechanics and the computer center of the Moscow Power Institute have developed and constructed a combined computer system based on the Minsk-11 computer and an MNB type analog computer, using a universal connecting unit. A description of the individual segments of the system is presented. TAB

N68-26586# Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Computer Science.
STEPS TOWARD A GENERAL PURPOSE TIME-SHARING SYSTEM USING LARGE CAPACITY CORE STORAGE AND TSS/360
Richard E. Fikes, Hugh C. Lauer, and Albin L. Vareha, Jr. Mar. 1968 38 p refs Submitted for publication
(Contract ARPA SD-146)
(AFOSR-68-0763; AD-668078)

This paper is a progress report of an effort at Carnegie-Mellon University to determine how a large capacity core storage facility (LCS) can be used to reduce the demand paging overhead costs in the IBM System/360 Time Sharing System (TSS/360) and in similar general purpose time-sharing systems. A discussion is presented of how the number of paging operations and the cost of each paging operation can be reduced by using LCS as both a swapping device and an extension of executable core. Two problems which arise are considered. A new algorithm for releasing core is presented and compared with two existing algorithms. Finally, results from a feasibility implementation of the ideas in a pre-release version of TSS/360 are presented as a demonstration of the validity of using LCS to reduce paging overhead. Author (TAB)

N68-26611# Atomic Energy Commission Research Establishment, Riso (Denmark). Electronics Dept.
HANDLING OF COMMON SUBROUTINES IN A SMALL COMPUTER MULTIPROGRAMMED SYSTEM (PDP 8/DR 2 SYSTEM)
L. P. Goodstein Feb. 1968 11 p
(RISO-M-707)

The problem of shared sub-routines in a multi-programming environment is treated. Emphasis is placed on the possibilities which exist for handling these sub-routines in a system incorporating a small PDP 8 computer. Author (NSA)

N68-26640*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
PRACTICAL STABILITY CRITERION AND ITS APPLICATION TO DIGITAL SIMULATION
Leslie L. Scalzott and Carl F. Lorenzo Washington Dec. 1967 36 p refs
(NASA-TN-D-4203) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A stability criterion has been developed for use with digital simulations or graphical data. The criterion used is a simple one, which basically requires ultimate state boundedness of the time function representing the system output. Techniques are established so that a transient of finite duration may be used as a practical indication of stability. A stability test utilizing the criterion has been implemented into a general digital program which will allow the determination of system stability directly by computer. This program and criterion was demonstrated for three applications representing: (1) a linear system, (2) a continuously nonlinear system, and (3) a discontinuously nonlinear system. Author

N68-26677# Oak Ridge National Lab., Tenn.
FORTRAN INPUT/OUTPUT FOR TAPES AND DIRECT ACCESS DEVICES
J. G. Sullivan 29 Feb. 1968 81 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2142) CFSTI: HC $3.00/MF $0.65

The flexibility of the new IBM system practically requires the programmer who has any need for extensive input–output use to develop an understanding of the devices, the facilities available to him, and the consequences involved with choices only he can rationally make. The relevant input–output devices on the ORNL 360/75 and the control facilities available to the programmer are described, and some guides to efficient use of the devices are presented. NSA

N68-26698# Maryland Univ., College Park. Dept. of Physics and Astronomy.
SUMX VERSION M-4
R. G. Glasser Dec. 1967 29 p refs
(Contract AT(40-1)-2504)
(ORO-2504-116; TR-763) CFSTI: HC $3.00/MF $0.65

SUMX is a computer program used to summarize and manipulate data. A description of the version of SUMX currently in use at the University of Maryland for analyzing the final physically relevant data from bubble chamber data analysis programs is presented. The program is written in FORTRAN IV. It has run on the Univac 1108 under FORTRAN V and on the IBM 7094 under IBSYS. NSA

N68-26736# Stanford Research Inst., Menlo Park, Calif.
HIGH-INFORMATION-DENSITY STORAGE SURFACES
Quarterly Report, 1 Oct.-31 Dec. 1967
Kendal T. Rogers, ed., Donald R. Cone, ed., and Louis N. Heynick, ed. Mar. 1968 32 p refs
(Contract DA-28-043-AMC-01261(E))
(ECOM-01261-11; QR-11; Rept.-11; AD-668242)

This program is devoted to the preparation and investigation of two novel kinds of electron-beam-addressable storage elements of submicron size and densely packed arrays of these elements; also to the construction of a large-capacity, high-speed, electron-beam-addressable, data-storage system utilizing regular arrays of these elements. Work on storage mosaics was devoted to further development of techniques for the preparation of regular arrays of densely packed micro-cap elements including: investigations of other resists besides tetrakistriphenyl siloxytitanium, such as KPR, Shipleys AZ 111, and poly(methyl methacrylate); argon-ion sputtering of molybdenum films; and lead-fluoride etching of aluminum-oxide films. Appropriate combinations of these techniques appear promising. The development of a computer program for the design of electron-optical systems capable of scanning 100,000,000 elements per field for mosaic fabrication and for element address is continuing. Concurrently, the present molybdenum-lens electron-optical system is being reassembled to include a velocity-selector/electron-multiplier readout unit and a bakeout heater. Author (TAB)

N68-26784# RAND Corp., Santa Monica, Calif.
APPLICATIONS OF BALANCED TREE SEARCH
Bennett Fox Apr. 1968 19 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5623-PR; AD-668119)

It is shown how balanced tree searching can accelerate incremental allocation and branch and bound algorithms by an order of magnitude. Author (TAB)

N68-26821# California Univ., Livermore. Lawrence Radiation Lab.
CONVERSATIONAL FOURIER ANALYSIS
J. R. McCall and C. E. Frerking 20 Feb. 1968 57 p
(Contract W-7405-ENG-48)
(UCID-15264) CFSTI: HC $3.00/MF $0.65

The program FOURIER is a general Fourier analysis code written for the LRL 6600 computers, allowing a user to direct the course of data handling through a conversation with the machine. The user may sit at a teletype and ask for operations such as data compression, Fourier analysis, and plotting and printing of Fourier coefficients. From the teletype the user requests a subroutine and provides it with the necessary arguments. Each available operation and its application and method of computation is discussed. Author (NSA)

N68-26925# Michigan Univ., Ann Arbor.
DESCRIPTION OF A SET-THEORETICAL DATA STRUCTURE
David L. Childs Mar. 1968 28 p refs
(Contract DA-49-083-OSA-3050; ARPA Order 716)
(TR-3; AD-668404)

A set-theoretic data structure (STDS) is virtually a floating or pointer-free structure allowing quicker access, less storage, and greater flexibility than fixed or rigid structures that rely heavily on internal pointers or hash-coding, such as associative or relational structures, list structures, ring structures, etc. An STDS relies on set-theoretic operations to do the work usually allocated to internal pointers. A question in an STDS will be a set-theoretic expression. Each set in an STDS is completely independent of every other set, allowing modification of any set without perturbation of the rest of the structure; while fixed structures resist creation, destruction, or changes in data. An STDS is essentially a meta-structure, allowing a question to dictate the structure or data-flow. A question establishes which sets are to be accessed and which operations are to be performed within and between these sets. In an STDS there are as many structures as there are combinations of set-theoretic operations; and the addition, deletion, or change of data has no effect on set-theoretic operations, hence no effect on the dictated structures. Thus in a floating structure like an STDS the question directs the structure, instead of being subservient to it. Author (TAB)

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N68-25669# Los Alamos Scientific Lab., N. Mex.
ANALOG PULSE DIVIDER USING FIELD EFFECT TRANSISTORS
H. Dean Sutphin 26 Feb. 1968 8 p refs
(Contract W-7405-ENG-36)
(LA-3818) CFSTI: HC $3.00/MF $0.65

The unique characteristics of field-effect were used in a circuit design for analog pulse division. The output pulse has an amplitude proportional to the ratio of the amplitudes of two unipolar input pulses. The instrument is capable of handling simultaneous pulses as well as those separated by several microseconds. Author (NSA)

N68-25737# Atomic Energy Commission Research Establishment, Riso (Denmark). Electronics Dept.
DESIGN OF A LOW-NOISE, CHARGE-SENSITIVE PREAMPLIFIER WITH FIELD-EFFECT TRANSISTORS
B. Chirilov Apr. 1967 20 p refs
(Riso-M-540; R-4-67) CFSTI: $3.00

The application of field-effect transistors in nucleonic charge-sensitive preamplifiers was demonstrated. A short discussion is given of these amplifiers; particularly, the noise performance is considered. On the assumption of single RC differentiating and integrating networks with equal time constants, the contributions to the equivalent noise charge from the different noise sources are found. In addition, the improvement of the noise performance that might be obtained by cooling and paralleling the input FET is mentioned. Finally, the experimental results obtained with a few samples of different types of field-effect transistors are presented. Author

N68-25757*# Little (Arthur D.), Inc., Cambridge, Mass.
FEASIBILITY STUDY OF THIN FILM TUNNEL CATHODES
Donald L. Sullivan Apr. 1968 27 p refs
(Contract NAS1-6291)
(NASA-CR-66617; C-68346-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Two types of deterioration in thin film tunnel cathodes were identified by direct transmission electron microscopy. Sputtered gold over sputtered bismuth oxide was investigated extensively as a thin cover metal film. The experimental evidence strongly suggests that the electron emission in tunnel cathodes is through many small holes in the cover metal, rather than by any direct hot electron transport process through the cover metal. Author

N68-25915*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
SOLID-STATE MILLIMETER WAVE POWER GENERATION AND AMPLIFICATION Semiannual Status Report, 1 Sep. 1967–29 Feb. 1968
Robert P. Rafuse 7 Jun. 1968 6 p refs
(Grant NGR-22-009-163)
(NASA-CR-94970) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The following research activities are reported: (1) construction and performance of high dynamic range mixers that give third- and fifth-order intermodulation terms greater than 120 dB at a +4 dBm two-tone signal input; (2) measurement analyses for oscillators at X-band and Ku-band; (3) device characterization and computerized design analyses for the development of high power and high efficiency varactor multipliers; (4) development of composite computer programs for diode data reduction and analysis, transition time calculations for punch through varactors, microwave measurement processing, etc.; (5) theory of low noise and dynamic range in symmetric mixer circuits; and (6) construction of a 23.5 GHz degenerate parametric amplifier and development of a low noise solid state 60 GHz receiver. G.G.

N68-26121*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
LOW NOISE AND DYNAMIC RANGE IN SYMMETRIC MIXER CIRCUITS
R. P. Rafuse [1967] 8 p refs Presented at the Conf. on High Freq. Generation and Amplification, Ithaca, N. Y., 29–31 Aug. 1967
(Grant NGR-22-009-163)
(NASA-CR-87749) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Controversies concerning low-noise mixer performance are discussed with particular reference made to the so-called magic noise temperature ratio of 0.5 for quality, p–n junctions and Schottky-barrier diodes, and to local oscillator waveform and the consequent diode conductance waveform. The point is made that the effective noise temperature ratio for a diode properly operated in a mixer cannot be significantly less than unity, and that a square wave, which would be disastrous in a single diode mixer, is ideal for a balanced mixer. Consideration is given to a four-diode balanced mixer, which can be represented by an ideal reversing switch provided series loss resistance and the depletion layer capacitance are neglected. It is reported that, based on this theory, a low-frequency mixer can be constructed with a conversion loss close enough to unity so that the extra loss is unmeasurable. M.G.J.

N68-26260# Northeastern Univ., Boston, Mass.
INVESTIGATION OF SOLID STATE DEVICES AND MATERIALS Final Report, Sep. 1964–30 Sep. 1967
Basil L. Cochrun, ed. 30 Sep. 1967 77 p refs
(Contract AF 19(628)-4759)
(AFCRL-67-0685; AD-668437)

The investigations carried out under the terms of this contract consist of three principle areas of endeavor: the characterization of semiconductor devices in terms of gain, impedance, frequency response and noise and unique applications of these devices to circuitry; a study of semiconductor and metal-semiconductor junction parameters; a study of materials and fabrication techniques leading to more efficient diode lasers. Author (TAB)

N68-26317# Army Electronics Labs., Fort Monmouth, N. J.
EFFECTS OF ULTRASONIC VIBRATIONS ON TRANSISTORS IN SUBASSEMBLIES
Robert R. Geisler Oct. 1967 24 p refs
(ECOM-2894; AD-667973)

The effects of an ultrasonic cleaning technique for removal of epoxy-type conformal coatings on printed wiring assemblies were investigated. The sample assemblies included (1) a standard comb-type printed wiring test pattern for evaluation of dielectric withstanding voltage, insulation resistance and Q, and (2) representative military type transistors mounted on printed wiring boards for evaluation of hFE and ICBO. Author (TAB)

N68-26377# Philco Corp., Palo Alto, Calif. Western Development Labs.
MAINTAINABILITY DEMONSTRATION RESULTS FOR 12 ELECTRONIC SUBSYSTEMS
Lynn V. Rigby Inglewood, Calif. AFSC, Space Systems Div. Dec. 1965 153 p refs
(Contract AF 04(695)-547)
(SAMSO-TR-68-159; AD-668182)

This report presents the procedures employed, the results obtained, and ancillary findings and insights gained from 12 separate maintainability demonstrations. These demonstrations were conducted in accordance with MIL-M-26512, on electronic equipment installed at five operating ground sites. A total of 419 simulated malfunctions were inserted into 11 of these subsystems under carefully controlled conditions, and the times required to diagnose and correct these malfunctions were recorded. The twelfth demonstration was based on analysis of field-generated trouble and failure reports. The results are sure to be of interest to both the theoretician and the practitioner in the field of maintainability engineering, and will hopefully serve and interest many in the broader areas of system planning, system simulation, and system evaluation. Author (TAB)

N68-26442# Harry Diamond Labs., Washington, D. C.
LOW-POWER EXPLOSION OF THIN-FILM RESISTORS
George K. Lucey, Jr. Jan. 1968 25 p refs
(HDL-TR-1376; AD-667949)

An equation is derived that may be used in conjunction with experimental power measurements to determine the temperature at which a thin-film resistor is burned out. The objective of the analysis is to provide information that may be used to assist in the design of an inexpensive, match-like detonator activated by the heat generated in a thin-film resistor pulsed by a capacitor discharge system. Author (TAB)

N68-26473# Varian Associates, Palo Alto, Calif.
STUDY OF METHODS TO IMPROVE HIGH POWER KLYSTRON LIFE AND RELIABILITY Final Report, 1 Jan.–31 Dec. 1967
John Brookshier Dec. 1967 72 p
(Contract DAAB07-67-C-0228)
(Rept.-346-1F; Rept.-4; AD-667970)

Studies were conducted in the following areas: Tests were conducted to measure the effects of thermal cycling and dc and ac steady-state operation upon the filament and mounting configuration of the cathode. Filament tie and focus electrode mounting were the main changes made. Studies were made to

improve the ability of the windows on the present VA-876 klystron to withstand the effects of arcing in the rf waveguide of the system. The improved window consisted of various half-wave ceramic block windows. Studies were conducted to measure the feasibility of a solid-state arc protection system that would be less sensitive to extraneous line variations, and stable over a long period of time and temperature ranges. A solid-state arc detector of stable design was the result of this study. Author (TAB)

N68-26479# General Electric Co., Owensboro, Ky. Tube Dept.
C-BAND AND X-BAND DUAL-FUNCTION OSCILLATORS Quarterly Report, 1 Sep.–30 Nov. 1967
J. D. Marshall and J. B. Quirk Ft. Monmouth, N. J. Army Electron. Command May 1968 16 p
(Contract DA-28-043-AMC-02340(E))
(RCS-OSD-1366; ECOM-02340-6; QR-6; AD-668929)

The triode development phase, which had been concluded during the last report period, was reopened for evaluations at X-Band and for investigations toward improving performance on life. Life tests at C-Band were terminated after 300 hours, and tabulated data for the ten samples is provided. X-Band evaluations were continued for tubes having etched frame grid structures, and having unsupported and undamped, tensioned grid structures. TAB

N68-26647# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FOUNDATIONS OF RELIABILITY AND OPERATION THEORY FOR RADIOELECTRONIC EQUIPMENT
N. A. Shishonok, V. F. Repkin, and L. L. Barvinskiy 3 Oct. 1967 730 p refs Transl. into ENGLISH of the book "Osnovy Teorii Nadezhnosti i Ekspluatatsii Radioelektronnoy Tekhniki" Moscow, Izd. Sovetskoye Radio, 1964 p 1–551
(FTD-HT-67-154; AD-668250)

This book treats basic problems of reliability theory and the operation of radioelectronic devices. The authors examine quantitative indicators of reliability and methods of their engineering calculation and statistical evaluation. Methods for basing demands upon reliability are discussed. Ways to increase reliability at the expense of reserving and to operate the apparatus efficiently are taken into account. The authors have considered the influence of preventive measures and repair operations on reliability. The influence of the control systems parameters on the reliability of the apparatus is also treated. Finally, the authors have dealt with problems concerning the efficiency of complex systems and methods for the simulation of their functioning processes which take reliability into account. The book is intended for university students taking courses in the principles of reliability. It can also be used by engineering and technical personnel who are engaged in the design, manufacture and operation of radioelectronic devices.
Author (TAB)

N68-26653# Harry Diamond Labs., Washington, D. C.
AN L-BAND STEP-RECOVERY-DIODE MULTIPLIER
Howard I. Bassen Mar. 1968 18 p ref
(HDL-TM-68-9; AD-667951)

A times-six multiplier development study was made in an effort to facilitate efficient frequency conversion from the 215- to 260-MHz telemetry band to the new 1435- to 1535-MHz telemetry band. Such a multiplier would enable use of gun-rugged crystal-controlled oscillators to provide stable transmitter capabilities at L-band. A stripline, times-six multiplier was developed using a special gun-rugged step recovery diode in the shunt mode. An efficiency of 39 percent was achieved at 1440 MHz with output powers as high as 3 W attainable at this efficiency level. The physical construction is readily adaptable to the high-shock environments of artillery telemetry. Author (TAB)

N68-26662*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECTS OF NUCLEAR RADIATION ON A HIGH-RELIABILITY SILICON POWER DIODE I-CHANGE IN 1–5 DESIGN CHARACTERISTICS
Julian F. Been Washington Jun. 1968 37 p refs
(NASA-TN-D-4620) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Tests were conducted on 100 diodes in the NASA Plum Brook Reactor facility, which was designed to simulate a SNAP-8 nuclear environment. The diodes were irradiated in different operational and temperature modes for approximately 480 hr, with a resultant diode exposure to a total fast-neutron fluence (energies of 0.1 MeV and above) of 5×10^{13} neutrons/cm^2 and to a total gamma dose of 3×10^7 rads (C). Results showed that this diode could be reliably used in a nuclear electric generating system such as SNAP-8 provided that the total radiation levels were within those of the tests. No catastrophic failures occurred. The electrical characteristic that would limit the useful lifetime of the device with increased radiation is the forward voltage drop at high current levels. Author

N68-26780# Ion Physics Corp., Burlington, Mass.
HIGH VOLTAGE BREAKDOWN STUDY Quarterly Progress Report, 16 Aug.–15 Nov. 1967
W. R. Bell, M. J. Mulcahy, and A. Watson Mar. 1968 139 p refs
(Contracts DA-28-043-AMC-00394(E); DA-01-67-C-001; ARPA Order 517)
(QPR-12; ECOM-00394-12; AD-667904)

Statistical and physical analyses of the block of eight experiments were carried out for unconditioned gaps and for conditioned gaps with and without perpendicular magnetic field. The other factors examined were anode and cathode treatment (vacuum or hydrogen firing) and electrode size. Prebreakdown current and breakdown voltage values were examined in the statistical analysis. Second order and higher order interactions were found to be important in addition to main factor effects. The magnetic field significantly affected the breakdown voltage and also interacted with other factors. The theoretical model of the breakdown mechanism developed was consistent with the results and trends of the statistical analysis. The 300 kv apparatus was disassembled for complete overhaul, cleaning and remachining. This included electropolishing of the vacuum chamber and polishing of all gold O-ring surfaces. The box heating oven was replaced with a form fitting as heater blanket unit and the controls for both and the electrode heaters were made completely automatic. The latter have now been removed from the vacuum envelope and the complete system has been reassembled, baked and made vacuum tight. Author (TAB)

N68-26794# Atomic Energy Establishment, Winfrith (England). General Reactor Physics Div.
FIXED DIODE FUNCTION GENERATING EQUIPMENT
F. C. Kingdon Nov. 1967 12 p ref
(AEEW-M-749) CFSTI: HC $3.00/MF $0.65

The system developed for the generation of arbitrary functions of computed variables to be used in conjunction with the PACE analog computer is described. It is intended to give sufficient detail to allow programmers to build up functions for themselves. Author (NSA)

N68-26811*# Stevens Inst. of Tech., Hoboken, N. J.
MODELING INTEGRATED CIRCUITS FOR COMPUTING
Gerald J. Herskowitz [1967] 5 p refs Presented at the Natl. Electron. Conf., Chicago, 23–25 Oct. 1967
(Grant NGR-31-003-050; Contract DA-28-017-AMC-3187(A))
(NASA-CR-87646) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The integrated circuit modeling procedures described are a review of those presently employed in available computer programs and of proposed techniques which appear promising for future programs. Procedures for modeling integrated circuits are based upon a compromise between accurate representation of the physical processes and simplification through approximation techniques. Included is a description of the commonly used elemental-equivalent modeling technique which is sufficient in most applications to obtain approximate response computer solutions. Lumped-parameter modeling is developed and applied to model typical integrated circuit component. Modeling of MOS integrated circuits, which are finding wide application in large arrays, and models of thin and thick film integrated circuits are also discussed.
A.L.

N68-26831 European Organization for Nuclear Research, Geneva (Switzerland). Nuclear Physics Div.
DETECTION EFFICIENCY OF VARIOUS PHOTOTUBES FOR CERENKOV LIGHT [EFFICACITE DE DETECTION DE DIVERS PHOTOTUBES POUR LA LUMIERE CERENKOV]
P. Duteil, J. P. Garron, R. Meunier, J. P. Stroot, and P. Spighel 24 Apr. 1968 59 p refs In FRENCH
(CERN-68-14)

Relative value of the spectral sensitivity of the photocathodes and the absolute value of the photoelectron collection were measured as a function of the wavelengths of the incident light for different phototubes. An anomaly found in the form of the efficiency curves for the phototubes indicated sensitivity of the photocathodes as far as the ultraviolet spectrum. This increase in efficiency was explained by the enrichment of electrons in the photoelectron spectra; and the phenomenon was related to semiconductor properties in the cesium antimonide layer. The curves permit determination of the threshold and the average distance of electron hole pair production in the cesium antimonide by the primary photoelectrons for which the energy is degraded. The probability of simultaneous double emission next to the layer is found to be practically nil, which is particularly important in terms of detecting Cerenkov radiation. Transl. by M.W.R.

N68-26863# Matsushita Research Inst. Tokyo, Inc., Kawasaki (Japan). Electron Device Lab.
STUDIES OF INFRARED IMAGE CONVERTER (SOLID STATE TYPE AND VACUUM TYPE) Progress Rept.
Koh-ichi Miyaji Dec. 1967 92 p refs
(Contract DAJB17-67-C-0611)
(J-255-5; AD-667995)

Theoretical and experimental studies were performed in an effort to obtain an infrared image converter. In Part I, the introduction of cooling has brought excellent results for improving the sensitivity of photoconducting CdSe powders. The optimum operating temperature in sensitivity was found OC for both CdSe:Cu, Br and CdSe:Cu, Cl. As the result of a study on Cd1-xHgxTe powder, its operation for 1.5 microns in AC-DC system has become possible at low temperatures. In Part II, two systems, i.e., optoelectrical feedback and thick photoconductor systems, were proposed for the improvement in performance characteristic of the image converter. In the latter system, the minimum detectable input obtained was 6 x 10 to the minus 9th power w/sq cm. In Part III, main efforts were directed toward the improvement of the emission efficiency in Si photoemitter. The comparison of measured and calculated values for emission has been carried out. Measurements of energy distribution of the emitted electrons have also been made in this period. Author (TAB)

N68-26918 Ohio State Univ., Columbus.
LIMITING FACTORS IN JUNCTION CIRCULATOR DESIGN
Yerriah Pantulu Vaddiparty (Ph.D. Thesis) 1966 190 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-6379

The electrical properties of a circulator, which is a nonreciprocal device, are discussed. For purposes of design, analysis of a stripline-type junction circulator is presented in a slightly modified form from the earlier analysis that was available. The circulation conditions were programmed by a computer and presented in graphical form. Practical design details and drawings are presented. The earlier analytical solutions for circulation conditions assumed that the device operated under a steady magnetic field well removed from ferrimagnetic resonance. For values of static magnetic field in the vicinity of the ferrimagnetic resonance, the real parts of the permeability tensor are of the order of magnitude of the dissipative parts. An attempt was made in this dissertation to show that circulation conditions can be applied to a ferrite junction circulator operating near the ferrimagnetic resonance by modifying the propagation constant with a weighting factor. To facilitate graphical analysis, the modified transverse permeability was computed by using a compound variable involving the magnetic field, the applied frequency, and the ferrite magnetic parameters. The results were plotted graphically and used to verify several experimental results obtained. Dissert. Abstr.

N68-26953# Systems Research Labs., Inc., Dayton, Ohio.
DIELECTRIC RELAXATION EFFECTS IN A METAL OXIDE PLASMA CAPACITOR
Robert A. Olson and G. Medicus (AF Avionics Lab.) Wright-Patterson AFB, Ohio AF Avionics Lab. Mar. 1968 18 p refs Presented at the 8th Ann. Meeting of the Am. Phys. Soc., Boston, 2-5 Nov. 1968
(Contract AF 33(615)-2662)
(AFAL-TR-67-348; AD-668532)

Measurement of K*C sub g, the complex dielectric constant K* times the geometrical capacity c sub g, of a metal-oxide-plasma capacitor have shown that K* exhibits dispersion in the audio frequency range. A series of dielectric-relaxation spectra has been obtained for Al203 layers (anodized) by varying the plasma density. The dependence of the spectra on plasma density and oxide thickness is indicative of Maxwell-Wagner behavior. A cole-cole representation of the data shows a broadening of the dispersion toward low frequency, with a secondary dispersion appearing at low frequency. The main dispersion can be described by an empirical dispersion formula which represents an asymmetrical distribution of relaxation processes. There are indications that the secondary dispersion is the result of the migration of ions injected from the plasma into pores in the oxide coating.
Author (TAB)

N68-26957# Autonetics, Anaheim, Calif. Research and Engineering Div.
INVESTIGATION OF THIN-FILM OPTICAL TRANSMISSION LINES Final Report
C. B. Shaw, Jr. and B. T. French Feb. 1968 50 p refs
(Contract AF 49(638)-1504)
(C7-929.1/501; AFOSR-68-0583; AD-668553)

Document reports completion of three-year program of theoretical and experimental research on thin film dielectric structures as electromagnetic waveguides at optical frequencies, and guides reader to six publications on results obtained. Analysis was based on an integral equation for electric field in higher-index dielectric region only. Index may be continuous or discrete function of position. A variational method was developed which yields dispersion curves for two dominant modes of infinite cylinder of arbitrary cross section. Numerical results were for rectangular cross section of finite width. Input and output problems for semi-infinite cylinders were given very general unified formulation, embracing single or multimode propagation, neglecting only evanescent modes. Computational difficulties arise in waveguide analysis

since kernel of integral equation is singular. Fast, accurate new numerical method to find eigenvalues and eigenfunctions of integral equation with singular kernel was developed, and tested successfully on a one-dimensional model equation having known solutions. An experimental technique for fabrication of thin film dielectric waveguides or optical transmission lines was developed and several experimental lines fabricated and evaluated. Collimated monochromatic visible light was transmitted by these structures under specific conditions. Polarization of transmitted light in plane of structural films was observed. Detection of output, including polarization phenomenon, was by direct observation and conventional measurements, and also by use of silicon planar photodiodes implanted directly in the substrate of the structure. Author (TAB)

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N68-25932 *# Tennessee Univ., Knoxville. Dept. of Electrical Engineering.
ESTIMATION OF NONLINEAR DYNAMICS
J. D. Irwin and J. C. Hung 1967 8 p refs
(Grant NsG-351)
(NASA-CR-87789) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A technique for the estimation of nonlinear dynamics is presented. The computational algorithm involves only the solution of a set of nonlinear algebraic equations. The difference equations which described the nonlinear dynamics are derived, and the mathematical development of the problem is shown. The results indicate that by this method, the effort involved in solving a nonlinear discrete two point boundary value problem is reduced to that of solving a set of nonlinear algebraic equations. B.S.D.

N68-25982 Alabama Univ., University.
DESCRIBING FUNCTION ANALYSIS OF CONTROL SYSTEMS CONTAINING MULTIPLE NONLINEARITIES
Vinay Shridhar Sohoni (Ph.D. Thesis) 1967 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-8485

This dissertation deals in general with the analysis of nonlinear control systems by describing function techniques and in particular with the derivation of the describing functions for the multiple nonlinearities that are often encountered in practice. The describing functions which are both amplitude and frequency dependent are associated with the multiple nonlinearities in which there are one or more energy-storage units together with a nonlinear characteristic which is related to the energy-storage property in such a way that a mathematical separation into distinct linear and nonlinear parts is not feasible. Therefore, for multiple nonlinearities a family of describing functions has to be generated. Such families of describing functions are generated for two multiple nonlinearities; (1) a deadzone followed by a first order linear block and backlash, and (2) a hysteresis relay followed by a second order linear block and backlash. Furthermore the generated data are presented in their most useful form (Nichols plots as well as tables). Dissert. Abstr.

N68-25983 Alabama Univ., University.
STABILITY ANALYSIS OF NONLINEAR SYSTEMS BY FIRST METHOD OF LYAPUNOV
Qamar Uddin Ahmad Khan (Ph.D. Thesis) 1967 49 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8483

The first and second methods of Lyapunov constitute very powerful mathematical tools for stability analysis of nonlinear systems; however, both the methods have their advantages and limitations. The purpose of this dissertation is to develop further the first method of Lyapunov so as to make it more generally useful. An extension of the first stability theorem of Lyapunov is proved and an example is given to clarify the use of the theorem. The extension makes it possible to apply the first stability method of Lyapunov to a broader class of systems than the systems to which the original theorem could be applied. Also, a set of necessary conditions for the boundedness of solutions is established and a method for predicting instability by way of comparison is developed. A theorem regarding the boundedness of solutions, which is particularly useful for the analysis of feedback control systems having more than one nonlinearity, is also developed. Dissert. Abstr.

N68-25988 Pennsylvania Univ., Philadelphia.
OPTIMUM DESIGN AND SYNTHESIS USING MATHEMATICAL PROGRAMMING
Joseph Ovar Bergholm (Ph.D. Thesis) 1966 186 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-7819

The application of mathematical programming to network synthesis provides a unified approach to a wide variety of time domain and frequency domain problems. This study deals with the synthesis of electric networks, but the same procedures can be applied to any system that possess an electrical analog. The application of mathematical programming to a specific synthesis problem comprises a flexible procedure that provides unified control over several important aspects of approximation and realization. A synthesis problem arises once a desired characteristic, c(u), has been specified. The variable u corresponds to the time variable in a time domain problem, and to the frequency variable in a frequency domain problem. The first step of the synthesis procedure is to choose an initial approximation series with which to approximate the desired characteristic. Dissert. Abstr.

N68-25993# Illinois Univ., Urbana. Coordinated Science Lab.
ESSENTIAL PARAMETERS IN SENSITIVITY ANALYSIS
Dennis F. Wilkie and William R. Perkins Apr. 1968 25 p refs
To be presented at the 2d IFAC Symp. on System Sensitivity and Adaptivity, Dubrovnik, Yugoslavia, 26–31 Aug. 1968
(Contract DAAB07-67-C-0199; Grant AF-AFOSR-931-67)
(R-376; AD-668486)

A method is developed to generate by one nth order sensitivity model all the sensitivity functions the partial derivative of x sub i with respect to q sub j, q superscript o, i = 1,...,n,j = 1,...,r for a single input, linear, time-invariant, controllable nth order system which depends on r different parameters. This represents an improvement over known methods for generating the sensitivity functions, which generally require a composite dynamic system of order n(r + 1). In the development, two useful properties of the sensitivity functions of the states of the companion form of a system (i.e. the system A matrix is in companion form) are used. It is shown that all the sensitivity functions of the states of the companion form system can be generated by linear combinations of the signals on one sensitivity model of the system and the system states. The Leverrier algorithm has been extended so that the method of the paper is readily implemented on a digital or hybrid computer. Finally, an example is given, demonstrating how the technique of the paper can result in considerable time savings in the computer simulation and sensitivity analysis of systems. Author (TAB)

N68-25996 Michigan Univ., Ann Arbor.
NONLINEAR INTERACTION THEORY FOR CROSS-FIELD DISTRIBUTED-EMISSION AMPLIFIERS

Thomas Andrew De Massa (Ph.D. Thesis) 1966 262 p
Available from Univ. Microfilms: HC $11.95/MF $3.40 Order No. 67-8239

A generalized nonlinear electron-wave interaction theory is developed for the crossed-field emitting-sole amplifier in order to explain the physical phenomena involved in the interaction. The effects of d-c, r-f and space-charge forces are taken into account and secondary emission from the sole electrode is included in the theory. The large-signal charge group and r-f wave variables as calculated using the equations are illustrated in graphical form for various d-c and r-f conditions. The d-c parameters are chosen in most cases to correspond to synchronous operation. At the same time, however, these parameters are chosen for d-c operation above, below and at the magnetron cutoff condition. Solutions for operation above, below, and at cutoff are obtained. An approximate set of equations is derived by neglecting space-charge forces and assuming the gain parameter D to be small. Solutions for various sets of d-c parameters, using this "hard-kernel-bunch" approximation, are presented. Dissert. Abstr.

N68-26006 University of Southern Calif., Los Angeles.
ASYNCHRONOUS FINITE-STATE CONTROLLERS FOR DYNAMIC SYSTEMS
Charles Richard Walli (Ph.D. Thesis) 1967 322 p
Available from Univ. Microfilms: HC $14.65/MF $4.15 Order No. 67-8037

Methods were developed for the analysis and synthesis of a new class of nonlinear controllers, asynchronous finite-state sequential machines, for dynamic systems. The synthesis methods consisted of relegating the system dynamics to a secondary role, partitioning the space of the dynamic system into disjoint areas, developing a strategy, and then applying asynchronous sequential circuit design techniques to synthesize the controller. Synthesis procedures were developed and illustrated by the design of simple sequential machines, composed of only a few flip-flops, for the attitude control of a space vehicle in one degree-of-freedom. Methods for the analysis and characterization of the stability of asynchronous finite-state controlled systems were developed by extending the Second Methods of Lyapunov. A low friction single degree-of-freedom platform was constructed as a space vehicle model to provide additional experimental verification. It was found that the use of the primitive flow table description of the machine facilitated the synthesis and analysis in each area investigated. Dissert. Abstr.

N68-26009 California Univ., Berkeley.
ANALYSIS OF NONLINEAR NETWORKS
Harold Robert Hill (Ph.D. Thesis) 1966 181 p
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-8567

The solution of nonlinear resistive networks is of interest because it is the key to the solution of nonlinear RLC networks. Necessary topological conditions for a unique solution have been derived for resistive networks without dependent sources. Conditions for the existence of a unique solution to the network equations were derived by obtaining an expression for the Jacobian determinant of the mapping represented in the equations, and requiring that the expression be positive globally. The topological determinant expansion rule derived for this purpose is valid for a hybrid-matrix network representation based on a reference tree of the network graph. Topological expansion rules for the partial derivatives of driving-point and transfer characteristics of nonlinear resistive networks without dependent sources have been obtained. Dissert. Abstr.

N68-26037# Technische Hochschule Munchen (West Germany).
ALTERNATING CURRENT COMMUTATION [EXPERIMENTELLE UND ANALYTISCHE STUDIE UEBER DIE ZUSAETZLICHEN KURZSCHLUSSSTROEME BEI WECHSELSTROMKOMMUTIERUNG]
Max Figel (Ph.D. Thesis) 1967 101 p refs In GERMAN
CFSTI: $3.00/MF $0.65

Studied are the interference currents in short circuit armature coils and in brush friction loss at shunt loads caused by the electromagnetic coupling factor in the transformer of an alternating current commutator. Experimental results with short circuit armature coils and constant rotation induction showed that short circuit power losses as well as the firing brush intensities depended strongly on brush widths. Transl. by G.G.

N68-26249# Michigan Univ., Ann Arbor.
A SURVEY OF THEORETICAL DYNAMIC ANALYSIS METHODS FOR AUTOMATIC FLIGHT CONTROL DESIGN
Alfred C. Robinson Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Mar. 1968 198 p refs
(Contract AF 33(615)-1817)
(AFFDL-TR-67-147; AD-668472)

The report is a survey of the theoretical methods in automatic control systems and their applications in the flight control field. A brief review of the classical methods is given. Recent developments in modern automatic control analysis applicable to flight control design and synthesis are emphasized. A bibliography of some of the pertinent articles and books is also included. Author (TAB)

N68-26278# City Coll. of the City of New York.
ELECTROSTATIC FOCUSING ON HOLLOW SPIRALING ELECTRON BEAMS Triannual Report Number 3, 1 Aug.–30 Nov. 1967
Morris Ettenberg Mar. 1968 27 p
(Contract DAAB07-67-C-0159)
(ECOM-0159-3; AD-667906)

The detailed design for an end fire experimental gun was completed. All the parts have been machined and only final assembly remains to be accomplished before vacuum testing. The computer program for trajectory plotting including space charge effects has been completed. A sample computer calculation is included as an appendix to this report. Author (TAB)

N68-26289# Michigan State Univ., East Lansing. Div. of Engineering Research.
EFFECT OF SUBSYSTEMS INFORMATION FEEDBACK ON THE ENTROPY OF THE WHOLE SYSTEM. PART 1: FULLY INDEPENDENT SYSTEM Quarterly Scientific Report No. 1, 1 Sep.–30 Nov. 1967
M. Z. A. Krzywoblocki Ft. Monmouth, N. J. Army Electron. Command Apr. 1968 58 p refs
(Contract DAAB07-67-C-0586)
(ECOM-0586-1; QSR-1; AD-667913)

The area of research treated in Quarterly Scientific Report No. 1 is that of fully independent subsystems. The whole system is subject to transformation. A subsystem is transmitted from the sending source system to the transmission system and next to the receiving system. Formulas are given in the report for the entropy of three systems, sensitivity coefficient, etc., and refer to a one-partition system, two partition system and multi-partition systems. The concept of normalization is used and the formalism of it will be presented in a future scientific report. Author (TAB)

N68-26296# Army Electronics Labs., Fort Monmouth, N. J. Electronic Components Lab.
DESIGN AND ANALYSIS OF A STATISTICAL EXPERIMENT ON HIGH-VOLTAGE BREAKDOWN IN VACUUM

M. M. Chrepta, G. W. Taylor, and M. H. Zinn Feb. 1968 19 p refs
(ARPA Order 517)
(ECOM-2939; AD-668241)

The results of an experiment designed as a quarter replicate of a 2 to the 7th power plan on factors effecting high-voltage breakdown in vacuum are given. The significance of each of the seven factors is analyzed, showing the effect of electrode materials, electrode geometry, electrode finishes, and the bakeout process. A good degree of confidence was obtained showing that the anode material and anode geometry are important in the cause for breakdown. The results of these statistically designed experiments and other experiments performed investigating the activity in high-voltage gaps lead to the conclusion that anode effects play a major role in the breakdown process. Upon completion of the full line of designed experiments, the information gained from this work will be compiled in charts and graphs as a design monograph for the high-voltage high vacuum component design engineer. Author (TAB)

N68-26343# Varian Associates, Palo Alto, Calif.
INVESTIGATION OF ELECTRONIC INTERACTION WITH OPTICAL RESONATORS FOR MICROWAVE GENERATION AND AMPLIFICATION Second Triannual Report, 16 Jul.–15 Nov. 1967
Howard Jory Mar. 1968 23 p refs
(Contract DA-28-043-AMC-01873(E))
(Rept.-341-2-TRIA; Rept.-10; ECOM-01873-7; AD-667898)

Additional experimental results with model 2 of the monotron oscillator are described. Oscillations were observed on resonances ranging from the TE sub 6,1,1 at 40.7 GHz to the TE sub 10,1,1 at 76 GHz. Peak power outputs of up to 25 W (not including a 3 dB factor for thermistor efficiency and insertion loss of waveguide components) have been measured. Some difficulty was encountered with a bad connection between the aluminum collector film and its kovar support. The tube was disassembled; a stainless steel mesh was installed as a beam collector, and the tube was reassembled. Detailed measurements of the rf output pulse shape were made. A rise time in the range of 5 to 10 nsec was observed. The possibility of constructing an oscillator for 337-micron wavelength (890 GHz) is investigated. Dielectric loading of the TE sub n,1,1 cavity with a thin film of dielectric on the cylindrical wall of the cavity appears to be a good approach for the circuit of such an oscillator. Author (TAB)

N68-26351# Army Electronics Labs., Fort Monmouth, N. J.
AZIMUTHALLY DEPENDENT MODES ON UNIFORM SOLID ELECTRON BEAMS
Bruno Zotter Dec. 1967 36 p refs
(ECOM-2928; AD-667905)

The dispersion relation in the slow wave approximation for a finite electron beam in a finite magnetic field is solved for the azimuthal mode numbers m = plus or minus 1. The modes are grouped into space-charge, cyclotron and synchronous waves according to their characteristics. Normalized radial propagation constants and plasma frequency reduction factors are plotted versus the normalized longitudinal propagation constant with the ratio of plasma to vortex frequency as parameter. These plots are frequency independent and allow construction of the omega-beta diagram by a simple graphical method. Numerical results are presented for a beam-to-tunnel diameter ratio of 0.8. Author (TAB)

N68-26385# Aerospace Corp., El Segundo, Calif. Applied Science Dept.
SEQUENTIAL STATE AND PARAMETER ESTIMATION IN DISCRETE NONLINEAR SYSTEMS
George W. Masters, Jr. Apr. 1968 147 p refs
(Contract F04695-67-C-0158)
(TR-0158(3306)-1; SAMSO-TR-68-163; AD-668116)

The work presented in this report derives a sequential method for on-line estimation of the state variables and parameters of discrete, non-linear, dynamical systems. A discrete version of Pontryagins Maximum Principle is employed to obtain the canonic equations of the least-squares optimal estimator. A discretized invariant imbedding technique is then applied to solve the resulting two-point boundary value problem. Finally, a system of sequential equations is obtained by application of variational methods to the optimal trajectory. The result is a sequential estimation scheme conceptually related to existing methods developed for continuous systems. The method presented has the advantage of direct applicability to discrete systems and provides for the inclusion of higher-order terms not usually considered by other methods. As a result of these inherent features, the process has been found to provide a faster, more stable estimate of the system variables. In addition, a minimum of a-priori statistical information is required. Author (TAB)

N68-26469# New York Univ., N. Y. Electroscience Research Lab.
INVESTIGATION OF NETWORK REALIZABILITY 2 Final Report, 1 Nov. 1965–31 Jan. 1968
Mohammed S. Ghausi 29 Feb. 1968 28 p refs
(Contract AF 19(628)-5537)
(TR-400-180; AFCRL-68-0117; AD-668434)

The final report describes the results of our research under contract AF 19(628)-5537 from November 1, 1965 to January 31, 1968. The study covered the following general areas of investigations which are compatible with integrated circuits. (a) The analysis and design of RC distributed networks. (b) Design methods for active RC networks and related problems. The report briefly summaries these investigations and lists all publications which have resulted under this contract. TAB

N68-26492# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON INCREASE OF SPEED OF OPERATION OF CERTAIN SYSTEMS OF AUTOMATIC CONTROL [OB UVELICHENII BYSTRODEYSTVIYA NEKOTORYKH SISTEM AVTOMATICHESKOGO REGULIROVANIYA]
N. Kh. Shatskiy 14 Jul. 1967 20 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Elektromekhan. (Novocherkassk), no. 7, 1965 p 783–790
(FTD-MT-67-59; AD-668513)

Optimal transients are considered in automatic systems where the principal control signal depends on the deviation of the controlled variable from its set value. The optimal transient process consists of acceleration and deceleration, both having a constant maximum value. The angular velocity linearly depends on time. The shortest transient process requires the functioning of a negative feedback and a time-proportional positive feedback. The second derivative of speed is selected as a control input that can ensure the speed-time linear relation. A negative feedback proportional to the error-signal first derivative is suggested for changing the sign of the control input. Restricting the error signal is proposed to ensure minimum duration of the control process for different initial errors (deviations). The above ideas are illustrated by an example of an automatic vector-measuring device. Shapes of control-signal curves are shown and explained. TAB

N68-26582# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATING ONE CLASS OF EXTREMUM SYSTEMS OF DISCRETE ACTION UNDER THE INFLUENCE OF RANDOM INTERFERENCES [ISSLEDOVANIY ODNOGO

KLASSA EKSTREMAL'NYKH SISTEM DISKRETNOGO DEYSTVIYA PRI VOZDEYSTVII SLUCHAYNYKH POMEX]
N. M. Aleksandrovskiy and N. Ye. Madzharov 28 Jul. 1967 15 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Elektromekhan. (Novocherkassk), no. 7, 1965 p 733–739
(FTD-MT-24-116-67; AD-668056)

An automatic-control system in which the sampled signal is used for both controlling the actuator and forming the control law is theoretically considered. It is assumed that: the plant is first-order linear; the sampling period is much longer than the total time of control operations. It is found that considerable deviations from the absolute optimum do not seriously affect system accuracy; the latter increases up to a certain value of gain; beyond that value, the extremum-tracking error becomes higher again because of the increased hunting amplitude. Recommendations for selecting the optimal system gain are given. Formulas are developed for the steady-state error of the sampling-data system subjected to noise; in these formulas, the plant inertia is allowed for. TAB

N68-26863# Wisconsin Univ., Madison. Mathematics Research Center.
OPTIMAL REGULATION OF NONLINEAR DYNAMICAL SYSTEMS
D. L. Lukes Feb. 1968 37 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-844; AD-668396)

The paper develops a theory of optimal control for processes described by autonomous systems of nonlinear ordinary differential equations. The admissible controls are feedback devices which operate on the sensed state of the system to automatically generate control signals that return the system to a prescribed state of equilibrium whenever an impulsive disturbance occurs. An optimal control is defined by means of a performance integral that provides a basis of comparison between certain feedback controls. By assuming that the process is stabilizable the existence and uniqueness of an optimal control is proved. Both C superscript omega and C superscript 2 systems are treated and several examples are discussed. Author (TAB)

N68-26783# Stanford Research Inst., Menlo Park, Calif.
PROPERTIES OF CELLULAR ARRAYS FOR LOGIC AND STORAGE Final Report, 14 Jan. 1966–13 Oct. 1967
Bernard Elspas, William H. Kautz, and Harold S. Stone Nov. 1967 61 p refs
(Contract AF 19(628)-5828)
(AFCRL-68-0005; AD-668085)

The report presents final results of a third project covering research on cellular logic techniques. The objective of the research has been to develop techniques for the efficient realization of general logical functions in cellular arrays. The report covers the subjects of cellular cascades and related networks: studies of universal logic modules; programmed-logic arrays; diagnosis and testing of cellular arrays; sampled-sequence detectors, serial universal logic modules, and iterative multirail cascades. Author (TAB)

N68-26875*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VOLTAGE BREAKDOWN IN ELECTRONIC EQUIPMENT AT LOW AIR PRESSURES
Earle R. Bunker, Jr., ed. 15 Dec. 1966 498 p refs Proc. of Workshop held at JPL, 18–20 Aug. 1965
(Contract NAS7-100)
(NASA-CR-95089; JPL-TM-33-280) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Conference proceedings centered on the engineering and design of high-voltage spacecraft electronic equipment required to operate or pass through the critical air pressure region. For individual abstracts, see N68-26876 through N68-26911.

N68-26876*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VOLTAGE BREAKDOWN PROBLEMS AT LOW AIR PRESSURES ENCOUNTERED IN THE MARINER 4 SPACECRAFT
Earle R. Bunker, Jr. *In its* Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 1–21 (See N68-26875 15-10)

Voltage breakdown phenomena at altitudes and problems that may be encountered are briefly discussed, and problems encountered on the Mariner spacecraft which were induced by vacuum equipment failure are reviewed. Problems resulting from the unreliability of vacuum testing systems and human operators; the elimination of the bleeder resistor in the power supply system; voltage breakdown in the high voltage transformer because of too much voltage between turns; and inaccuracies of instrumentation are discussed. It is suggested that all spacecraft equipment should be designed and exposed to operations in the critical region so that errors or failures of the vacuum system can be eliminated. S.C.W.

N68-26877*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
HIGH-VOLTAGE BREAKDOWN PROBLEMS IN GODDARD SCIENTIFIC SATELLITES
Harry W. Street *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 23–36 refs (See N68-26875 15-10)

High voltage breakdown problems encountered in the following Goddard scientific satellites are reported: the Nimbus spacecraft system; the OSO II (OSO II-B) spacecraft; the Explorer series of satellites; the S-51 spacecraft; the S-52 spacecraft; the S-6 spacecraft; and the OGO spacecraft. Discussed are problems resulting from failure to use suitable insulating materials for electric wiring and connectors; insulation breakdown; inadequate potting materials; and inadequate thermal vacuum testing techniques. The significance of reported findings to future planning for the successful operation of high voltage equipment in the space environment is discussed, and methods for correcting design problems are recommended. S.C.W.

N68-26878*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
CORONA INDUCED FAILURES ON *NIMBUS A* DURING GROUND TESTING
S. Charp *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 37–44 (See N68-26875 15-10)

Corona induced failures (high voltage connectors and camera electronic systems) on Nimbus A during ground testing discussed and methods used to eliminate future corona problems are described. S.C.W.

N68-26879*# Kollsman Instrument Corp., Syosset, N. Y.
HIGH VOLTAGE CONSIDERATIONS FOR THE DETECTOR ASSEMBLY USED IN THE GODDARD EXPERIMENTAL PACKAGE
Peter Pokalsky *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 45–52 (See N68-26875 15-10)

High voltage design specifications for the detector assemblies (ultraviolet photon counters) used in the Goddard experimental package are discussed; and techniques used in the fabrication and testing of circuit components and insulating materials are reviewed. S.C.W.

N68-26880*# Stanford Research Inst., Menlo Park, Calif.
ELECTRICAL BREAKDOWN MECHANISMS AFFECTING SPACE SYSTEMS

Edward F. Vance and John Chown *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 53–80 (See N68-26875 15-10)

Discussed are: (1) electrostatic problems related to vehicle charging; (2) low voltage arc discharges associated with high power and low voltage DC systems in plasma environments; (3) multipactor discharge; and (4) breakdown as a gaseous discharge or glow discharge. Author

N68-26881*# Harvard Coll. Observatory, Cambridge, Mass.
HIGH-VOLTAGE EFFECTS IN SATELLITE-BORNE SPECTROMETERS
E. M. Reeves *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 81–95 (See N68-26875 15-10)

High voltage breakdown phenomena experienced during the Orbiting Solar Observatory experiments in which a scanning spectroheliometer was used to measure the incident energy from the solar disc in the wavelength region between 500 to 1,500 Å are discussed. In an attempt to assess possible causes of instrument failure which occured shortly after turnon in orbit, the prelaunch qualification program which was used to test the instrument was reviewed. It was found that in no case was a high voltage problem ever observed during qualification tests which included shock, excessive temperature soaks and fluctuations, and thermal vacuum. Following instrument failure in orbit, a series of tests were carried out on the flight's spare instrument in an attempt to determine the cause of high voltage breakdown. Possible causes as insufficient pumping of the instrument in the space environment; ions from some source either within or without the spacecraft; and normal spacecraft outgassing or leakage from the spacecraft or experimenter gas supplies are discussed. Since no one cause of high voltage breakdown could be found a shotgun approach was devised for prevention, and an improvement in all phases of the engineering was implemented. The proposed approaches are briefly described and the near completion of the prototype for the OSO-D instrument incorporating most of the proposed changes is reported. S.C.W.

N68-26882*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
DESIGN AND TEST OF A HIGH-VOLTAGE POWER SUPPLY FOR SATELLITE APPLICATION
F. Clauss, G. Dallimore, and D. Tashjian *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 97–109 (See N68-26875 15-10)

Reviewed are results of laboratory simulation experiments which were designed to determine what the pressure would be inside satellite payload boxes as compared to the standard ARDC atmosphere at 150 n mi. Of interest was whether the pressure within the payload and the power supply would be below the critical region. The possibility of assuming that the ARDC atmosphere would hold within the payload boxes was considered and various means of insulation for high voltage protection were studied. Outgassing experiments showed that potting of the test assembly would be the most feasible approach to high voltage protection. All high voltage circuitry was encapsulated and extensive testing was conducted at 10^{-1} and 10^{-2} mm Hg to assure that any unexpected outgassing or inadvertent turn-on would not ruin the system. Problems resulting from the incompatibility between the candidate potting compounds and the materials and metallic finishes are discussed. The problem of corona, and problems resulting at the connections where a wire terminated on a component are also discussed. To test whether a failure could be caused by operating in the critical pressure region, four thermocouple gages were installed in the vehicle. Results showed that they tracked the predicted ARDC atmosphere very closely. At 10^{-3} mm the gages bottomed out and never read on-scale again. It is concluded that although results seem to indicate that design considerations were conservative and the venting would have been an effective method of high voltage protection, inherent problems involved in venting as the sole method of voltage protection warrant the use of potting in this capacity. S.C.W.

N68-26883*# Consolidated Avionics Corp., Westbury, N. Y.
CONSTRUCTION OF POWER SUPPLIES FOR OPERATION IN THE CRITICAL REGION
J. P. Clark *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 111–117 (See N68-26875 15-10)

Materials and techniques used in the construction of power supplies for high voltage equipment operating in the critical region are discussed. Considered are methods used in eliminating corona in solids and liquids; potting of high voltage units for the partial pressure areas; inherent problems associated with the use of silicone rubber shielding around points that have a lower voltage; the use of stycast materials for higher voltages; and problems involved in the simple extension of power supplies to combine them with a photomultiplier tube or a similar detection device. Multiple tests used in detecting corona problems in high voltage supplies are also reviewed. S.C.W.

N68-26884*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
THE GENERATION OF POTENTIAL DIFFERENCES AT STAGE SEPARATION
J. W. Haffner *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 119–125 (See N68-26875 15-10)

Since voltage breakdown failures and anomalies occur at the same altitude range during which first stage separation of a launch vehicle often occurs, experiments were performed to determine if there could be a potential difference generated between the two stages of the vehicle as it separates. Three geometries were studied: a cone (A), a cylinder (B), and two identical cylinders (C). These geometries were basically cardboard and aluminum foil models. Theoretically the greatest effect was expected from configuration A, a less effect with configuration B, and zero effect with configuration C. Procedures used to ensure that the potentials measured upon separation of the cone and cylinder were not due to the unequal leakage of charge from these two bodies are described. Experimental procedures consisted of: (1) recharging the two bodies while they were in contact; (2) removing the high voltage lead and thus effectively isolating the bodies; (3) separating the bodies a given distance; and (4) measuring the potential difference between the two bodies as a function of time. Results for all three configurations were consistent with theoretical predictions. Also performed was an experiment which involved removing the cone away from the cylinder in configuration A, reversing the cone, and then bringing it back to the cylinder. A small spark was detected (audibly). Results indicate that there will be a potential difference between two bodies at stage separation assuming these two bodies have different sizes and shapes. Since these measurements were taken at atmospheric sea level pressure, no electrical discharges were detected. S.C.W.

N68-26885*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
CURRENT ANOMALIES AT SEPARATION
W. R. Abbott *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 127–135 (See N68-26875 15-10)

Short circuit and other anomalies occurring at or near the time of separation of the Agena rocket from the booster are discussed. Analyzed are seven of nine short circuit anomalies which were observed. Three of these anomalies stopped with the pull-away plug separation indicating that a short was on the booster side of the pull-away plug and opened at this time. The anomalies

on two of the vehicles stopped at approximately the end of retro fire. With the exception of one vehicle, all anomalies occurred with separations of 52.5 miles or lower and it was therefore concluded that they were altitude dependent. Another phenomenon that appeared to be altitude dependent was that of loss of telemetry data. It was postulated that the loss was due to the attenuation caused by the transmission of the signal through the plasma in the retro rocket plume. The altitude dependency was a result of the rocket plume increasing in size as the ambient pressure decreased at higher altitudes. The other source of attenuation was that which occurs when the frequency is below the Langmuir resonant frequency of the plasma. Using the known telemetry frequency and the observed attenuations, ion and electron densities to produce these attenuations were calculated. Densities of 10^9 to 10^{10} electrons/cm^3 were adequate to explain the observed attenuation. Voltage limits (low) for the induction of arcs by introducing a plasma in the interelectrode space were also studied. It was found that with a magnesium thorium cathode arcs could be produced at voltages as low as 26 v with ion densities of 10^9/cm^3 or less. With a copper cathode the required density was less than 10^{10}/cm^3. S.C.W.

N68-26886*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.

BOOSTER AND SPACECRAFT ELECTROSTATIC PHENOMENA: CAUSES, EFFECTS, AND PREVENTION

W. Coleman and R. Reeves *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 137–162 ref (See N68-26875 15-10)

Summarized are results of studies of electrostatic phenomena occurring in spacecraft and space vehicles. Primary objectives of these studies were to develop a general definition of the scope of the problem of electrostatic phenomena for the Apollo mission, and to define internal charging mechanisms. Summarized are results of initial studies designed to evaluate the internal charge sources for all the Saturn V stages, and studies of the effects and consequences of high voltage on isolated space vehicles. As a result of these studies the most critical phase of the Apollo mission was identified as the first phase which is from the launch pad until shortly after first stage separation. Discussed are possible hazards of internal and external charging mechanisms acting on the spacecraft. Engine charging mechanisms that were identified included thermionic emission, triboelectricity, photoelectric emission, and combustion products. Other charging mechanisms included atmospheric triboelectricity, thermionic emission, interaction with environmental charges, and photoelectric effects. Discharging mechanisms that prevent the attainment of an infinite voltage buildup were also identified. Those occurring in the atmosphere (corona and spark breakdown) and the ionosphere (collisions with environmental charges) are discussed. Techniques and approaches used to overcome problems of electrostatic phenomena on future missions are summarized. S.C.W.

N68-26887*# LTV Aerospace Corp., Dallas, Tex. Astronautics Div.

ELECTROSTATIC POTENTIAL SENSORS FOR USE ON THE NASA SCOUT EVALUATION VEHICLE S-131R

N. F. Bolling and R. L. Clark *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 163–191 refs (See N68-26875 15-10)

(Rept.-000TP001)

To obtain flight data for further evaluation of basic hypotheses and theories concerning electrostatic charging mechanisms related to Scout, two uniquely configured electrostatic voltage sensors were developed and installed on Scout vehicle S-131R to experimentally measure potential differences between parts of the vehicle during the launch trajectory and including staging. The electrostatic sensors developed are of the basic Field Mill type, but uniquely modified in such a way as to permit remote sensing of potentials due to electrostatic charging of the vehicle. Because of the differences in the characteristics of the two potentials to be measured, a low frequency response sensor unit and a high frequency response sensor unit were developed. Both sensors are polarity insensitive and will be used for in-flight measurements of (1) the electrical potential between the skin surface and the conducting inner structure of the upper B and C transition stages, and (2) the electrical potential between the first stage and second stage during separation. Presented are data on basic design requirements, fabrication techniques, and installation and checkout procedures. Recommendations for the modification of these sensors to meet future mission requirements are also discussed. S.C.W.

N68-26888*# Avco Corp., Wilmington, Mass. Research and Advanced Development Div.

PLANETARY BREAKDOWN STUDIES IN THE AVCO/RAD HIGH-VOLTAGE BREAKDOWN LABORATORY

W. B. Haigh *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressure 15 Dec. 1966 p 193–205 (See N68-26875 15-10)

Experiments on high voltage breakdown phenomena in planetary atmospheres such as those of Mars and Venus which were designed to derive analytical data applicable in the prediction of voltage breakdown of any antenna in any atmosphere are summarized. S.C.W.

N68-26889*# Avco Corp., Wilmington, Mass. Research and Advanced Development Div.

THEORETICAL STUDY OF MICROWAVE BREAKDOWN WITH APPLICATION TO SPACE VEHICLES

R. Fante *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 207–222 ref (See N68-26875 15-10)

Described are simple mathematical models which were designed to determine the effects of changing the structure of the effective field, the effects of flow velocity, the effect of not having a finite diffusion length but rather some infinite diffusion length, and nonlinear effects on microwave breakdown in spacecraft. S.C.W.

N68-26890*# Avco Corp., Wilmington, Mass. Missile Systems Div.

HIGH-ALTITUDE BREAKDOWN PREDICTION

G. A. Bakalyar *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 223-232 (See N68-26875 15-10)

Approximation methods for predicting the power at the onset of breakdown when a given antenna operates in a given gaseous medium over a variety of operating conditions are described. S.C.W.

N68-26891*# General Electric Co., Philadelphia, Pa.

ANTENNA VOLTAGE BREAKDOWN IN PLANETARY ATMOSPHERES

W. K. Kinkead *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 233–255 refs (See N68-26875 15-10)

In view of the low gas pressure expected to the found on the surface of Mars and other planets, as well as the need for substantial rf power to transmit information from such distant points back to Earth, voltage breakdown phenomena of antennas which represent significant design problems for future planet landing spacecraft were studied. Reported are results of studies designed to: (1) confirm scaling theory over the VHF to UHF range of frequencies with a variety of configurations and gas compositions; (2) to explore antenna breakdown conditions over a wide range of

gas compositions since it was recognized that present estimates of foreign planetary atmospheres were subject to many uncertainties; and (3) to develop methods for improving the power handling capability of basic antenna such as geometry optimization, use of super-imposed dc fields, and the use of light weight dielectric materials. Results indicate that: (1) unless foreign planetary atmospheres contain considerable portions of argon or other rare gases, antenna breakdown will not be significantly different than on Earth (at the same pressure); (2) end-loading and use of fiberglass-like dielectric materials can result in very large power handling improvements in monopole or multipole antennas with little increase in weight; (3) the use of dielectric sheaths on antennas should be carefully considered when ambipolar diffusion conditions can be obtained; (4) the use of dc bias for improving power handling of antennas is possibly not as effective in gases other than air for certain conditions; and (5) little difficulty, and lower frequency electrically small slot antennas can also be made to have adequate power handling capability. S.C.W.

N68-26892*# Motorola, Inc., Scottsdale, Ariz. Government Electronics Div.

SOLUTION OF A BREAKDOWN PROBLEM AT PARTIAL PRESSURES IN THE APOLLO LEM TRANSCEIVER

S. B. Newton *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 257–261 (See N68-26875 15-10)

This is a report of a problem encountered in the LEM transceiver during a low pressure environment test. The problem was a loss of RF output and appeared to result from a voltage breakdown in the high power variable reactance multiplier in the transmitter. The symptoms observed that led to this conclusion and the actions taken are described as they occurred. Author

N68-26893*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.

VOLTAGE BREAKDOWN IN AN EXPLODING BRIDGE WIRE SYSTEM

W. H. Brown *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 263–265 (See N68-26875 15-10)

Inflight high voltage breakdown induced by a conventional two pin connector used in an exploding bridgewire electronic system is assessed to illustrate a point of failure in an otherwise safe and reliable system. After failure occurred an immediate fix was made on the flight system by packing the connection with Dow Corning DC-4. The higher dielectric at the source of breakdown temporarily relieved the problem; however, the ultimate solution was a redesign of the disconnect system. The new design was incorporated in the pyrotechnic detonator and consisted of a coaxial connector with a high voltage ration of 2050 v. The new design gives high voltage carrying capability as well as allows good isolation from extraneous noises such as radiated radio energy. A coaxial connector carries the system wiring shield continuously through the connector. S.C.W.

N68-26894*# General Electric Co., Schenectady, N. Y. Advanced Technology Labs.

SOME ASPECTS OF BREAKDOWN AND CORONA PROBLEMS IN THE CRITICAL-PRESSURE RANGE

L. J. Frisco and W. T. Starr *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 267–274 (See N68-26875 15-10)

Voltage breakdown phenomena occurring in the critical pressure range are discussed, and a program desined to determine the performance of thin wall hookup wire in environments that might be experienced in the Apollo mission is described. S.C.W.

N68-26895*# Boeing Co., Seattle, Wash. Aerospace Group.

ELECTRICAL DISCHARGES AT ALTITUDES BETWEEN 70,000 AND 250,000 FEET

William G. Dunbar *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 275–287 refs (See N68-26875 15-10)

Experimental measurements of electrical discharges caused by corona, glow discharges, and voltage breakdown were made under conditions encountered in aerospace vehicles operating within the 70,000- to 250,000-ft altitude range. All measurements were made in gases commonly used to pressurize spacecraft electrical and electronic compartments: nitrogen, nitrogen-oxygen mixtures, and normal atmosphere at sea-level pressure. Test results show that: (1) the onset voltage at which the electrical discharge occurred is much lower for spaced wires than for bundled or twisted wires; (2) the onset voltage between wires increases as the insulation thickness and dielectric constant are increased and decreases as the wire diameter and wire spacing are increased; and (3) the onset voltage of components depends on the type of component and its connection and installation. Author

N68-26896*# Boeing Co., Seattle, Wash. Aerospace Group.

CRITICAL ALTITUDES FOR RADIO FREQUENCY BREAKDOWN

W. J. Linder *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 289–298 (See N68-26875 15-10)

Experimental data on rf breakdown which shows the variation of critical altitude with frequency and which defines this critical altitude are reviewed. Emphasized is the importance of comparative data to the antenna designer. S.C.W.

N68-26897*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.

MICROWAVE VOLTAGE BREAKDOWN AT CRITICAL PRESSURES

T. Breeden *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 299–309 (See N68-26875 15-10)

Analyzed are causes of arc power and dc voltage anomalies that were experienced during simulated tests of the Ranger spacecraft. Focused on were several voltage breakdowns occurring in the Ranger TV and communication subsystem when it was subjected to thermal vacuum tests. As a result of an extensive literature search, factors affecting breakdown were narrowed down to ionization and the multipacting phenomenon of secondary emission. Results of a research and development program which focused on actively enhancing the diffusion loss mechanism as a means of increasing the power handling capabilities of microwave components are discussed. S.C.W.

N68-26898*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

VOLTAGE BREAKDOWN INVESTIGATION IN THE ADVANCED PACKAGING TECHNOLOGY GROUP AT JET PROPULSION LABORATORY

Earle R. Bunker, Jr. *In its* Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 311–332 (See N68-26875 15-10)

Summarized are results of high voltage research designed to (1) establish parameters and techniques for high voltage packaging through the critical pressure region and in the high vacuum region; and (2) to improve instrumentation and established test procedures to determine if corona exists in equipment and components. Emphasized are voltage breakdown problems occurring in wire, cables, and connectors; and corona induced problems in spacecraft equipment. Studies to determine whether the intersection

of corona and arc curves exists at low pressures are summarized; visual and series network methods for detecting corona are described; and methods for testing components for spacecraft application are reviewed. S.C.W.

N68-26899*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Materials Engineering.
THE MATERIALS ASPECT OF CORONA AND ARCING PHENOMENA
Robert Boundy *In its* Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 333–346 (See N68-26875 15-10)

The apparent failure of Ranger VI due to the high-voltage arcing following an inadvertent power turnon in the critical pressure region in the Earth's atmosphere led to serious considerations of similar potential failure modes. The assumption is made that an inadvertent power turnon can be inhibited, and subsequent flights showed that it could. The following questions were considered: (1) When the high voltage is turned on after 65 hr of flight, will the black boxes of the TV system be evacuated below the critical pressure of approximately 10^{-4} torr? (2) During the 5-min warmup period prior to high-voltage turnon, will outgassing products raise the pressure into the critical region? (3) What is the lower limit of the critical pressure range for the various conditions that exist in the TV subsystem? In this paper, the background of this problem and the results of an experimental program designed to answer these questions (particularly the second question) are presented. The purpose of the experimental program was to determine the transient pressure rise in a typical volume with a known vent area as a result of heating samples of materials used in high-voltage units in the TV subsystem. Eleven materials were selected for testing, six of which were internal to the black boxes, while five were between the shroud and the black boxes. Materials tested included: epoxy fiberglass; Solithane 113/300; Stycast 1090/11; RCA 688; nylon lacing cord; Armstrong A-2/A; Rayolin-N; thermofit type CRN; nylon tie rap; PR-1527; and silicone rubber. Author

N68-26900*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE PRESSURE PROFILE OF A ROCKET EXPERIMENT AND METHODS OF REDUCING THE GAS LOAD
N. Mc Ilwraith *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 347–365 (See N68-26875 15-10)

Described are a plasma experiment which was developed and flown on an Argo D-4 rocket (Javelin) and which experienced difficulties with corona; results of pressure profile studies generated both in the laboratory and in a rocket-borne pressure gage; and techniques for minimizing the gas load. S.C.W.

N68-26901*# Westinghouse Electric Corp., Baltimore, Md.
GEMINI TRANSPONDER DEGASSING PROBLEMS
C. L. Brock and B. H. Vester *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 367–380 (See N68-26875 15-10)

An assessment of problems related to glow discharge phenomena which occurred in the transponder of the Gemini radar system is presented, and methods used to alleviate outgassing effects caused by light illumination are described. S.C.W.

N68-26902*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DIFFUSION OF GASES IN POLYMERIC FOAMS
E. F. Cuddihy and J. Moacanin *In its* Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 381–398 refs (See N68-26875 15-10)

It was found that the diffusion behavior of gases in rigid closed cell foams could be described mathematically by conventional diffusion equations. An experimental method was developed for the determination of diffusion coefficients of gases in foams. In addition, an equation was derived which relates the diffusion coefficient to the foam density ρ, the molecular weight of the blowing gas, and the density and permeation constant of the bulk polymer. The applicability of the equation was tested by experimentally measuring the diffusion coefficients for low density, rigid closed cell polyurethane foams containing CO_2. Author

N68-26903*# Hughes Research Labs., Malibu, Calif.
PREVENTION OF HIGH VOLTAGE BREAKDOWN IN ION PROPULSION SYSTEMS
G. A. Work *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 399–407 (See N68-26875 15-10)

Techniques used to prevent high voltage breakdown in the ion engine used on the NASA SERT-1 flight are described. Focused on were problems in the insulation of the power supply components which were induced by transient arcs and high voltage breakdown. Test criterion adopted was that all the elements of the circuits must operate at all pressures. To achieve this objective, adequate vacuum seals were effected using Teflon wire etched in sodium and ammonia. Another approach used to high voltage connector design was potting the connectors in a hard Stycast epoxy. It is shown that only by using this combination of hard epoxy and soft Teflon (which was etched to make a seal) was the all pressure operation achieved. Thermal cycling problems relating to high voltage connectors which caused a failure and consequently the SERT-I flight are also discussed. S.C.W.

N68-26904*# Hughes Aircraft Co., Culver City, Calif.
PREVENTION OF HIGH VOLTAGE BREAKDOWN IN ION PROPULSION SYSTEMS
R. Dunaetz *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 409–422 (See N68-26875 15-10)

Polyurethane foam encapsulation techniques used to maintain constant atmosphere and to provide mechanical protection against high voltage breakdown in ion propulsion systems are described. The applicability of the proposed techniques to the SERT-I ion engine program; Syncom synchronous satellites; and the Early Bird satellite is discussed. S.C.W.

N68-26905*# Westinghouse Research Labs., Pittsburgh, Pa.
MEASUREMENT OF CORONA DISCHARGE BEHAVIOR AT LOW PRESSURE AND VACUUM
T. W. Dakin and C. N. Works *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 423–439 refs (See N68-26875 15-10)
(Rept.-66-1B5-CORNA-P3)

The significance of the reduced electrical strength of low pressure air gaps near the Paschen's minimum is considered in relation to the proper operation of electrical systems in high altitude and space vehicles. Experiments are described which illustrate the occurrence and magnitude of partial discharges (corona) in air gaps between insulator and metal surfaces at low pressure and vacuum. The magnitude of the corona pulses observed with alternating voltages varied with pressure, being relatively small at atmospheric pressures and at pressures of about 10^{-1} torr where glow discharges occurred; the corona pulses were considerably larger for intermediate pressures and for pressures less than 10^{-1} torr. Although the pulse magnitude is low in the glow discharge region, considerable integrated charge may be transferred in this pressure region. Calculation of the pulse charge magnitudes indicated that the surface area discharged per pulse at low pressure is at least

1/3 to 1/2 of the total available area. The characteristics of corona discharges arising from direct voltages applied to low pressure gaps are also considered. Author

N68-26906*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

PREVENTION OF DIELECTRIC FAILURES IN SPACECRAFT

E. C. McKannan *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 441–443 (See N68-26875 15-10)

Summarized are design practices and packaging procedures for eliminating voltage breakdown problems in electronic components. A flight experiment designed to demonstrate the relative efficiency of the proposed packaging techniques is also described. It is expected that the experiment will be contained in a separate box on the instrument unit of a Saturn vehicle. The experiment will involve, mainly, a series of interdigitated, resistivity test patterns on printed circuit boards. Current flow and corona discharges will be measured at increasing voltages between two adjacent circuits on printed circuit boards under specified conditions. A specimen in the form of a guarded plate capacitor with one open mesh screen electrode, employing the same dielectric material as the printed circuit board, will be used and will provide information on dielectric constant or dissipation factor changes of the base materials during the experiment. Environmental conditions as temperature, pressure, solar radiation, and electrical field intensity in the vicinity of each specimen will also be measured. It is expected that with this experiment, some of the problems which occur in electronic components will be defined and the efficiency of the suggested solutions will be determined. S.C.W.

N68-26907*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PROBLEMS ENCOUNTERED USING CONNECTOR SEPARATION FOR OPENING LOW VOLTAGE CIRCUITS

J. R. Goudy *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 445–453 (See N68-26875 15-10)

As a result of a review of the Scout vehicle ignition harness, questions were raised as to the use of connector separation to open low voltage circuits. The phenomenon encountered during tests was arcing and flashover which was assisted by the critical air pressure region. Also, while corona was generally considered to be a problem in the 250 to 300 v range, the test uncovered a related problem in the 50 v range. To answer some of these questions, tests were run to determine whether the initial arcing from the female to the male pin was ionizing the gases remaining at the face of the connector, thereby resulting in an arc or flashover from female to female pin. Tests were run in a vacuum chamber, in which the vacuum ranged from 2.85 to 1.65 mm Hg or about 125,000 to 139,000 ft (a simulated altitude that was roughly that of second stage ignition on the Scout). The connector tested was a Deutsch DS-type connector. Approximately 100 tests were run varying the parameters with the following results: the voltage was varied from 32 to 60 v; the lowest voltage at which an arc was obtained was 40 v; the frequency of arc occurrence increased with voltage; and the duration of the arc was inversely proportional to the voltage lasting about 30 millisec generally at the 60 v level, while the arc obtained at 40 v lasted 1,026 millisec. Inherent problems associated with arc testing of this type are discussed, and the possible relationship between the observed problem and Agena problems are mentioned. S.C.W.

N68-26908*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.

SAFETY CONTROL IN SPACE ENVIRONMENTAL CHAMBERS

E. A. Jackson *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 455–465 (See N68-26875 15-10)

Instrumentation used to detect electrical discharge anomalies in vacuum chambers before they occur is described. Described are safety circuits (discharge and ionization gages) used for protection inside the chambers, and a sensor (ion gage) that detects when the pressure is at the point where a glow discharge or an arc might occur. S.C.W.

N68-26909*# Electro-Mechanical Research, Inc., Sarasota, Fla.

HIGH-VOLTAGE POWER SUPPLY DESIGN FOR OPERATION IN THE CRITICAL-GAS-PRESSURE REGIONS AND AT LOW TEMPERATURES (−55°C)

Aldus C. Myers, Jr. *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 467–483 refs (See N68-26875 15-10)

Summarized are efforts and results obtained in the development of a −10 kv power supply for Project Celescope, one of the Orbiting Astronomical Observatories. A review of past and present problem areas is given, and conclusions and recommendations for circumventing these problems are discussed. Improved packaging design concepts which have a higher probability of surviving in the critical pressure and low temperature environments are presented. Some desirable and undesirable characteristics of specific high voltage electrical components (diodes, capacitors, resistors) required to operate in the critical pressure environment and in the temperature range +50 to −55°C are discussed. Also, a discussion of high voltage wire and interconnections of high voltage wire that will survive the critical environment is presented. Dielectric media which may be used for operation in the critical environment are given consideration, and a simple but effective test fixture for passing high voltage wire into (or out of) a vacuum chamber without breaking the wire or wire insulation is described. Author

N68-26910*# Kollsman Instrument Corp., Syosset, N. Y. Space Div.

A HIGH-VOLTAGE PROBLEM ENCOUNTERED IN THE DESIGN OF THE STAR TRACKER USED ON THE ORBITING ASTRONOMICAL OBSERVATORY

James J. Collins *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 485–490 (See N68-26875 15-10)

Results of studies designed to determine the cause(s) of outgassing problems encountered in the Orbiting Astronomical Observatory program are reported. In this system, a Sun protect solenoid operated shutter is used to prevent sunlight from damaging the photosensitive detector. This unit moves an opaque shutter into the front end of the tracker obscuring the optical system. During the final acceptance tests of the system, an identical group of failures were noticed; in each case, the unit failed leaving the Sun shutter closed. At least four Sun protect units failed under thermal vacuum test or immediately thereafter. Each of these units had undergone extensive testing in normal environment. Several theories as to possible causes of failure were investigated among which included the possibility of transients appearing on the 28 v standby supply; the possibility of internal arcover; and the possibility that air spaces might be trapped under the surface of the Mylar in the dense packing area or that a film of air would exist because of poor bonding between the potting compound and the Mylar. The first two possibilities were ruled out; however, it was confirmed that outgassing occurred through the potting compound thus causing an air space inside the module to change pressure and go to a critical altitude equivalent. Possible solutions to overcome these problems are proposed. S.C.W.

N68-26911*# Chrysler Corp., New Orleans, La. Space Div.
SOLUTIONS TO POISSON'S EQUATION AND THEIR APPLICATION TO VOLTAGE BREAKDOWN PROBLEMS
Glenn E. Hagen *In* JPL Voltage Breakdown in Electron. Equipment at Low Air Pressures 15 Dec. 1966 p 491-499 (See N68-26875 15-10)

Solutions to Poisson's equation are presented and their applicability to problems of electrical breakdown due to a low pressure gaseous environment is discussed. It is concluded that from the standpoint of reliability, electrical circuitry which may be exposed to critical pressure should be designed with criteria of insulation and spacing consistent with intensities predicted by Poisson's equation rather than by those developed for the ordinary electrostatic stresses. S.C.W.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N68-25704*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HYDROGEN SAFETY MANUAL
Washington 1968 84 p refs
(NASA-TM-X-52454) CFSTI: HC $3.00/MF $0.65 CSCL 13L

A manual containing safety guidelines and standards for personnel handling and using hydrogen is presented. Prescribed precautions have general applicability as acceptable standards for meeting minimum safety requirements, and are designed to ensure that the life and health of personnel are not jeopardized and that the risk of damage to property is minimized. The nature of hazards of gaseous and liquid hydrogen, hydrogen-air mixtures, and hazards induced by diffusion and leakage of hydrogen are discussed. Design principles for test facilities, equipment, storage facilities, and related hardware are described. Included are discussions of procedures for eliminating ignition sources; protection of personnel and equipment; storage and test locations and blast effects; operating procedures; and emergency procedures. S.C.W.

N68-25733*# National Aeronautics and Space Administration, Washington, D. C.
MANNED UNDERWATER LABORATORY IN THE NORTH SEA INSTITUTE FOR AIR MEDICINE OF THE GERMAN RESEARCH INSTITUTION FOR AIR AND SPACE NAVIGATION AND BIOLOGICAL INSTITUTION HELGOLAND BUILD THE UWL "HELGOLAND" [BEMANNTES UNTERWASSER-LABORATORIUM IN DER NORDSEE, DAS INSTITUT FUR FLUGMEDIZIN DER DEUTSCHEN VERSUCHSANSTALT FUR LUFT-UND RAUMFAHRT E. V. UND DIE BIOLOGISCHE ANSTALT HELGOLAND BAUEN DAS UWL "HELGOLAND"]
Otto Kinne and Siegfried Ruff Jun. 1968 8 p Transl. into ENGLISH from Presse Inform. Deut. Versuchsanstalt fur Luft und Raumschiffahrt E. V. (Germany), no. 3, 3 May 1968 7 p
(NASA-TT-F-11785) CFSTI: HC $3.00/MF $0.65 CSCL 14A

The design of the projected underwater laboratory at Helgoland is briefly described. Provisions for the maintenance and medical surveillance of the laboratory personnel are indicated. The future research program, which consists of a medical, a psychological and a marine biology research program, is outlined. Author

N68-25777*# National Aeronautics and Space Administration, Washington, D. C.
A STUDY ON THE LARGE SCALE AIR EJECTOR
Shoichi Fujii, Mitsuo Gomi, and Noboru Sugahara Jun. 1968 32 p refs Transl. into ENGLISH from NAL-TR-109 Rept.
(NASA-TT-F-11378; NAL-TR-109) CFSTI: $3.00 CSCL 14B

The air ejector (length 7m, ejector diameter 6mm) was investigated experimentally and theoretically. Mass ratio range varied from 0 to 1.4, compression ratios from 1.03 to 1.38. The device is used with a single-stage axial flow compressor. Author

N68-25842*# Emerson Electric Co., St. Louis, Mo. Electronics and Space Div.
COMPILATION OF ROCKET SPIN DATA. VOLUME 1: ACCELERATION TEST FACILITIES Final Report
Leo J. Manda 15 Jun. 1968 67 p refs
(Contract NAS1-6833)
(NASA-CR-66625; Rept.-3001-1) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Various spin and centrifuge test facilities available for testing solid propellant rocket motors in acceleration environments are described. The capabilities of 25 test facilities available for spinning motors of various size about their longitudinal axes at rates up to 60,000 rpm are listed. Data sheets are also provided on 12 centrifuge test facilities capable of full scale motor testing at accelerations up to approximately 300 G's, and 2 strand-burner centrifuges. A.L.

N68-25853*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
EVALUATION OF A FULL-SCALE LUNAR-GRAVITY SIMULATOR BY COMPARISON OF LANDING-IMPACT TESTS OF A FULL-SCALE AND A 1/6-SCALE MODEL
Ulysse J. Blanchard Washington Jun. 1968 47 p refs Film Supplement Number L-993 to this report is available on loan from NASA Langley Res. Center, Langley Station, Va.
(NASA-TN-D-4474) CFSTI: HC $3.00/MF $0.65 CSCL 14B

In order to subject the structural components of the prototype lunar module (LM) to the dynamic loads and conditions imposed during lunar-landing impact, full-scale tests were needed. To conduct such full-scale tests on earth, lunar gravity must be simulated. A lunar-gravity simulator for conducting landing-impact tests of a full-scale vehicle was constructed and evaluated. Results of landing tests of a full-scale test model of the LM conducted on the lunar-gravity simulator compare favorably with results of free-body tests of a similar 1/6-scale dynamic model conducted under earth gravity. Landing-gear strokes, center-of-gravity accelerations, and pitching motions were in good agreement. The full-scale simulator adequately reproduces two-dimensional landing-impact dynamics and is suitable for conducting detailed studies of prototype LM structure during landing impact. The effect of structural elasticity on landing motions and stability could also be investigated with the simulator. Author

N68-25858*# Brown Engineering Co., Inc., Huntsville, Ala.
TWO-HUNDRED INCH MULTI-CELL (PRESSURE TEST)
Jon J. Spano May 1968 204 p ref
(Contract NAS8-20073)
(NASA-CR-61222) CFSTI: $3.00 CSCL 14B

A pressure test was conducted on a multi-cell tank configuration to provide basic stress information and determine the effects of discontinuity under a maximum water pressure of 30 psi bottom bulkhead. Lag effects in the waffle skin, elastic distribution of stresses through the radial tension web, and basic path loads were also studied. A complete strain gage computer printout is included. There were no structural failures in the tank after the test. M.W.R.

N68-25859*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A 14 TESLA 15-CM BORE SUPERCONDUCTIVE MAGNET
W. D. Coles, E. R. Schrader (RCA, Harrison, N. J.), and P. A. Thompson (RCA, Harrison, N. J.) [1967] 15 p refs Presented at the 1967 Cryog. Eng. Conf., Palo Alto, Calif., 21–23 Aug. 1967
(NASA-TM-X-60367) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Design and construction of a 14 Tesla 15-cm bore superconductive magnet presented problems which were intensified by the size and field strength requirements. The magnet is a solenoid of approximate dimensions of 15-cm ID, 50-cm OD, and a length of 35-cm. The weight is approximately 1000 pounds and the stored energy when powered to maximum field strength approaches 2 megajoules. Selection of the conductor to match the field, strength, and stability requirements resulted in a modular design concept. An iterative computer program was used to optimize the design characteristics. Due to the large mass of the magnet, cooling of the internal parts was essential. This was accomplished by means of grooves and holes in the support structure which provided for the in-flow of liquid helium and for the escape of helium gas. Tests indicate: (1) The design and protection objectives were met. (2) Advantages offered by the magnet are: ripple free operation with little electrical noise; no acoustic noise or vibration; and a large volume at room or liquid helium temperatures. (3) Long charging time affects the magnet's utility for some experiments. (4) The magnet is probably over-protected but the degree to which protection could be reduced has not been assessed. A.L.

N68-25875# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
METHODS OF IMPROVING POINT-LIGHT SOURCE TECHNIQUES FOR APPLICATION TO AUTOMOBILE DRIVING SIMULATORS
Roy S. Rice Jun. 1967 14 p
(CAL-YM-1783-V-1)

A study undertaken to enhance the brightness of a visual scene produced by a point-light source/transparent model board system indicated that considerably more research is required before such a system can be used effectively in an automobile driving simulator. Point-light sources were investigated, along with specific optical characteristics of materials and fluids; and a comprehensive file on these was compiled. Light loss because of reflection at low angles of incidence causes the scene to be quite dim and results in a very short depth of field. M.W.R.

N68-25958*# National Aeronautics and Space Administration, Washington, D. C.
WALLOPS STATION, WALLOPS ISLAND, VIRGINIA
1968 4 p
(NASA Facts 0-11/12-67) GPO: HC $0.15; CFSTI: MF $0.65 CSCL 14B

As part of its educational program, NASA presents a fact sheet on the research and development work being performed at the Wallops Station. Although primary emphasis is placed on gathering data about the earth's atmosphere and its near-space environment and on supporting the national sounding rocket program, mention is also made of the experiments designed to obtain scientific information on flight characteristics of vehicles and spacecraft, and of the basic testing and development of components, systems, subsystems, and instrumentation to be flown in later types of vehicles and spacecraft. M.G.J.

N68-25959# National Bureau of Standards, Washington, D. C.
TECHNICAL HIGHLIGHTS OF THE NATIONAL BUREAU OF STANDARDS Annual Report, 1967
Nov. 1967 163 p refs *Its* Misc. Publ. 293
GPO: HC $0.55; CFSTI: MF $0.65

The future requirements of American industry, commerce, and science are discussed in the context of the traditional NBS role of leadership in developing the measurement methods and standards needed to meet this more complex and technically-oriented society. The systems approach is described in terms of two interlocking subsystems: the intellectual or conceptual system, and the oprational system. Details are also given on the work being done by the three institutes which comprise the NBS: the Institute for Basic Standards, the Institute for Materials Research, and the Institute for Applied Technology. The functions and activities of the National Standard Reference System are also described. Organizational and funding data are included, along with a bibliography of publications. M.G.J.

N68-26331# Lincoln Lab., Mass. Inst. of Tech., Lexington. Lincoln Lab. Library.
MILLSTONE AND HAYSTACK SCIENTIFIC AND TECHNICAL PUBLICATIONS
9 Apr. 1968 30 p refs *Its* Bibliography no. 36
(Contract AF 19(628)-5167)
(ESD-TR-68-56; AD-668435)

This document is a bibliography of most of the significant publications, in whatever form, resulting from the work conducted at the Millstone Radar Facility and the Haystack Microwave Research Facility, two of the major instruments at Lincoln Laboratorys Millstone Hill Field Station. Author (TAB)

N68-26713# Naval Ordnance Lab., White Oak, Md.
HYPERSONIC PITCH-DAMPING SUPPORT USING WATER COOLED BALL BEARINGS
Frank J. Regan and Eugene V. Horanoff 26 Jan. 1968 35 p refs
(NOLTR-68-4; AD-668325)

Free oscillation pitch-damping measurements were made on a nine degree half-angle cone at a Mach number of 8.0. The report discusses the design of the support, the water cooling system and its effectiveness in controlling the thermal environment of the bearings. In addition, an outline is given of a theoretical technique for calculation of the damping in pitch derivative for slender cones called the shock expansion method. Comparisons are made between theory and experiment. Author (TAB)

N68-26714# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
IMPLOSION DRIVEN HYPERVELOCITY LAUNCHER PERFORMANCE USING GASEOUS DETONATION WAVES
John D. Watson Wright-Patterson AFB, Ohio ARL Dec. 1967 77 p refs
(Contract AF 33(615)-2766)
(UTIAS-TN-113; ARL-67-0278; AD-668223)

An experimental investigation of the performance of an Implosion-Driven Hypervelocity Launcher was made in preparation for the investigation of launcher performance using explosive liners. Initial gaseous mixtures of stoichiometric hydrogen and oxygen diluted with hydrogen or helium in the initial pressure range from 100 psi to 500 psi were used. The detonation velocities and the subsequent trajectories of the reflected shock waves in the hemispherical combustion chamber were determined for the various initial mixtures. The measured detonation velocities in this high-pressure range agree very well with theory. Gun performance for the various reservoir conditions was investigated and the performance utilizing imploding shock waves is compared to the performance using deflagrating or constant volume combustion. Author (TAB)

N68-26822# California Univ., Livermore. Lawrence Radiation Lab.
FIRST EXPERIMENTS WITH THE IMPROVED ASTRON FACILITY

N. C. Christofilos 29 Feb. 1968 16 p refs
(Contract W-7405-ENG-48)
(UCID-15294) CFSTI: HC$3.00/MF$0.65

The observations in these experiments were limited in measurements of E-layer lifetime and observations of the precession phenomena as a function of the loading factor of the E-layer. NSA

N68-26823# California Univ., Livermore. Lawrence Radiation Lab.
GLASS-METAL ENVELOPE FOR HIGH VACUUM X-RAY IRRADIATION OF SPECIMENS AT ELEVATED TEMPERATURES
C. A. W. Peterson and W. J. Steele 31 Jan. 1968 20 p
(Contract W-7405-ENG-48)
(UCID-15254) CFSTI: HC$3.00/MF$0.65

Description of a high-vacuum tube for X-ray irradiation of specimens at elevated temperatures is presented. X-ray diffraction data, obtained using the tube, are presented for a Mulberry alloy at 150 to 573°C. NSA

N68-26924# Atomic Energy Commission, Washington, D. C. National Accelerator Safety Committee.
SAFETY GUIDELINES FOR HIGH ENERGY ACCELERATOR FACILITIES
1967 33 p refs
(TID-23992) GPO: HC$0.30; CFSTI: MF$0.65

Guidelines are suggested relating to management, buildings and facilities, equipment design, and procedures. Radiation protection and electrical safety guidelines are treated only in a peripheral manner. NSA

N68-26937*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPANSION TUBE (TUNNEL) INVESTIGATIONS Progress Report
Robert L. Trimpi Washington 14 Sep. 1967 29 p refs
Presented at the AGARD Fluid Dyn. Panel Meeting, Goettingen, W. Ger., 14–15 Sep. 1967
(NASA-TM-X-60447) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The effects on non-ideal diaphragm openings, wall viscosity, fluid mixing, contamination and other possible detrimental effects arising from the real physical conditions in which the expansion tube and tunnel must operate were studied. The expansion tube is a new device for producing high enthalpy short duration hypersonic gas flows and will be used to study hypervelocity reentry physics. Results of these studies indicate that: (1) the expansion tube or tunnel is capable of producing hypervelocity flows in density ranges of interest; (2) test section cores approximately one-half the test section size are typical; (3) the free stream turbulence level does not appear prohibitive; (4) although test times are short, they are long enough for the establishment of attached flows over many models; (5) diaphragm contamination still appears to be an unsolved problem for radiation testing if pressure bursting of diaphragms is employed; however, other possibilities for diaphragm removal may alleviate this condition. S.C.W.

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N68-25747*# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
RESEARCH ON GAS-SURFACE INTERACTIONS, 1966–1967. PART 1: PROJECT SUMMARY Final Report, 11 Aug. 1966–11 Oct. 1967
Richard A. Oman, Vincent S. Calia, and Calvin H. Weiser Dec. 1967 16 p refs
(Contract NASw-1461)
(NASA-CR-94968; RE-310) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A high intensity shock tube driven molecular beam system was investigated for use in surface interaction experiments; and molecular beam density variations, fixed nozzle operation, and time of flight measurements in the beam are discussed for the system. Mention is made of an analytical scattering model and atomic recombination at a surface; and two methods developed for preparing and analyzing surfaces for targets are surface treatment of crystals and surface deposition. M.W.R.

N68-25795*# Techtran Corp., Glen Burnie, Md.
CHARACTERISTIC METHOD FOR COMPUTING TWO-DIMENSIONAL EQUILIBRIUM AND PERFECT GAS VORTEX FLOWS [METOD KHARAKTERISTIK DLYA RASCHETA DVUMERNYKH VIKHREVYKH TECHENIY RAVNOVESNOGO I SOVERSHENNOGO GAZA]
Yu. N. D'Yakonov, L. V. Pchelkina, and I. D. Sandomirskaya Washington NASA May 1968 21 p refs Transl. into ENGLISH from "Vycheslitel'nyye Metody i Programmirovaniye. Chislennyye Metody v Gazovoy Dinamike Sbornik Rabot Vychislitel'nogo Tsentra Mgu" Moscow, Univ. Press, no. 7, 1967 p 206–224
p 206–224
(Contract NASw-1695)
(NASA-TT-F-11694) CFSTI: $3.00 CSCL 20D

After briefly discussing the merits of the nets and characteristics method for computing supersonic flow regions, the authors propose and describe a possible scheme for using the characteristics method for computing a steady, two-dimensional vortex flow of a perfect gas, and particularly of an equilibrium gas flow at M_∞=6 past blunt bodies. The scheme is so designed as to be suitable for computerized solution with or without taking equilibrium physical-chemical reactions into consideration. The results of several computerized solutions are presented graphically. Analysis of results reveals quantitative and qualitative differences in gas flow patterns in vortex layers for plane and axisymmetric flows past blunted bodies. Author

N68-25800*# Mississippi State Univ., State College. Dept. of Aerophysics and Aerospace Engineering.
MEASUREMENT OF POINT VELOCITIES IN TURBULENT LIQUID FLOW
Ronald W. Greene and Stanley K. Burt Dec. 1967 57 p refs
(Contract NAS8-20383)
(NASA-CR-61837; RR-83) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The existing statistical theories of turbulence rely on data obtained experimentally for their implementation. Therefore, a method of determining statistical distributions of the necessary turbulence parameters is desired. The method should be applicable to a system such as a liquid propulsion system; consequently, the investigation was carried out in the turbulent flow of water. In general cases of nonsteady fluid motion, the hot-wire anemometer technique is a basic quantitative method for measuring velocity fluctuations. Extension of the hot-wire technique to conducting liquids by industry has produced changes in sensor design resulting in development of the quartz-coated, hot-film sensor. The hot-film technique is applied, as a basic experimental method, to the turbulent flow of water in a pipe. In Part II, an elementary

photographic method is developed to obtain quantitative measurement of velocity fluctuations in the cases of turbulent flow behind a grid and in a pipe. Author

N68-25866*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LIQUID INFLOW TO INITIALLY EMPTY, HEMISPHERICAL ENDED CYLINDERS DURING WEIGHTLESSNESS
Eugene P. Symons, Ralph C. Nussle, and Kaleel L. Abdalla Washington Jun. 1968 16 p refs
(NASA-TN-D-4628) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An experimental investigation was conducted in a weightless environment during which liquid was pumped into hemispherical ended cylinders which were initially void of liquid. During inflow, two distinct types of liquid-vapor interfaces were observed; a stable interface and an unstable interface. The stability of the liquid-vapor interface was correlated by a Weber number based on inlet line radius and inlet velocity. Results indicate that above a Weber number of 1.3, the interface became unstable. Furthermore, this filling process was independent of the radii of the experiment tanks (2 to 4 cm). No gross effects due to the viscosity of the test liquid were observed. Author

N68-25888# Central Mechanical Engineering Research Inst., Durgapur (India).
FLOW INSTABILITIES IN HYDRODYNAMIC DRIVES
Pulak De Nov. 1967 10 p refs
(B4) CFSTI: HC $3.00/MF $0.65

A theory of flow instability related to resonance behavior of the contained rotating fluid in hydrodynamic drive is suggested. It is shown that it can explain certain torque-surges. Another case of torque-fluctuation that occurs when the driving is suddenly stopped, is explained by considering the behavior of the fluid in the reservoir space. Author

N68-26000# New York Univ., N. Y.
BOUNDARY LAYER CHARACTERISTICS FOR HYPERSONIC FLOW WITH AND WITHOUT MASS ADDITION
Antonio Ferri and Victor Zakkay Wright-Patterson AFB, Ohio ARL Jan. 1968 91 p refs
(Contract AF 33(615)-2215)
(ARL-68-0002; AD-668460)

Problems connected with viscous hypersonic flow with and without mass addition were theoretically and experimentally investigated. Specific viscous flow phenomena investigated are: the boundary layer with large density gradients, the mixing in the presence of a wall, and the mixing of two fluids in the presence of pressure gradients. In the field of viscous flow with mass addition, nonsimilar, nonequilibrium, laminar boundary layers with surface ablation of subliming plastic materials were investigated analytically. In addition, research was performed in a spectrum of related fields. Author (TAB)

N68-26017 California Univ., Los Angeles.
BOUNDARY LAYERS IN ROTATING FLOW WITH HEAT TRANSFER
John Thomas Ohrenberger (Ph.D. Thesis) 1967 180 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-9032

Boundary layers in strongly rotating perfect gas flow on fixed axisymmetric surfaces of finite radius are investigated. These have been the subject of many incompressible flow studies. Here, the energy equation is added, and the effect of energy coupling on the momentum boundary layer, and the nature and development of the thermal boundary layer are studied. In general terms, the flow pattern is one in which fluid enters the boundary layer at the larger radii, spirals inwards toward the center, and is smoothly and continuously returned to the external flow near the axis. Under the conditions that the flow is isoenergic (constant total enthalpy), the Prandtl number is one, and viscosity varies linearly with temperature, a transformation was found which reduces the momentum equations to those describing a family of incompressible rotating flows. Dissert. Abstr.

N68-26043 Michigan Univ., Ann Arbor.
SMALL LIQUID OSCILLATIONS IN MOVING CIRCULAR AND ELLIPTIC CYLINDRICAL CONTAINERS
Ernest Christian Glauser (Ph.D. Thesis) 1968 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8257

Small oscillations of an ideal, incompressible liquid in moving rigid circular and elliptic cylindrical containers are analyzed, using a classical approach in the dynamics of continuous media. The motion of the liquid is expanded in a series with time dependent coefficients with respect to the natural modes of free oscillation. The motion in the liquid is considered to be the superposition of two parts: the motion if surface waves are suppressed and the motion due to surface waves alone. The problem of forced oscillations is therefore solved in three principal steps: The eigenvalues and eigenfunctions are obtained from the solution of the free oscillation problem in the container at rest. A series solution is presented for the moments of inertia of liquid in elliptic cylindrical containers with respect to rotations about the two principal axes through its centre of gravity. Curves and tables supplement the known results for the circular cylindrical container with results for elliptic cylindrical containers which are of most practical interest. Containers partially filled with an ideal, incompressible liquid can be described by an infinite set of linear, second order differential equations. Dissert. Abstr.

N68-26048 State Univ. of Iowa, Iowa City.
ENGINEERING ASPECTS OF BARRIER SEPARATION OF GASEOUS MIXTURES
Max Everett Breuer (Ph.D. Thesis) 1967 175 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-9044

The effect of various parameters on barrier separation of gas mixtures was studied. Particular emphasis was placed on the concentration conditions in the gas phase adjacent to both sides of the barrier. The separation of helium-nitrogen and helium-carbon dioxide mixtures was studied using microporous Vycor glass as the barrier, in addition nitrogen-carbon mixtures were investigated with a silicone rubber barrier. The parameters studied included: pressure on both sides of the barrier; feed concentration; cut, i.e., fraction of the feed permeating the barrier; the geometry of the separating cell, and the permeabilities of the individual gases composing the mixtures. The concentration gradient was measured. The purpose of measuring the concentration gradient was twofold: Some assumption as to the nature of the concentration gradient is necessary; therefore knowledge of the actual gradient will be useful in formulating a model. By measuring the concentration gradient, one can calculate the permeability coefficient for an individual gas in a mixture, as well as in the pure gas state. Dissert. Abstr.

N68-26057# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INTERFERENCE MEASUREMENTS MASS TRANSFER IN A TURBULENT BOUNDARY LAYER OF A PERMEABLE SURFACE [INTERFERENTSIONNYYE IZMERENIYA MASSOPERENOSA V TURBULENTNOM POGRANICHNOM SLOYE PRONITSAYEMOY PROVERKHNOSTI]

L. A. Fayngol'd 28 Jul. 1967 14 p refs Transl. into ENGLISH from the publ. "Teplo- i Massoobmen Tel s Okruzhayushchey Gazovoy Sredoy" Minsk, Nauka i Tekhnika, 1965 p 123–129 (FTD-MT-24-105-67; AD-668112)

The object of the work was the interferometric measurement of the concentration field of an admixture (carbon dioxide gas) blown into a turbulent boundary layer through a permeable surface under isothermal conditions. The experimental apparatus consisted of an open type aerodynamic tube with a closed working column 0.8 meters long and with a cross section 190 x 360 mm. The porous plate being investigated was placed in the lower wall. The flow velocity through the plate was varied smoothly up to 40 meters/sec. The porous plate was made of stainless steel and had dimensions of 0.28 x 0.35 x 0.005 meters. Photography of the radiation process was done with a Zenith-S camera directly on the apparatus. A formula is derived for the direct calculation of the profiles of the relative carbon dioxide concentrations in the boundary layer with blowing of carbon dioxide gas. Author (TAB)

N68-26067 Cornell Univ., Ithaca, N. Y.
APPLICATION OF PLASTICITY THEORY TO THE PREDICTION OF FLOW PATTERNS IN A METERING DEVICE FOR GRANULAR MATERIALS
Bernard Edwin Romig (Ph.D. Thesis) 1967 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-9197

The flow of granular materials in metering devices has not been described mathematically and all design of such devices has been done empirically. The work reported here is an attempt to extend the theory to the case of an axisymmetric rotor in which the material is caused to flow through an opening by the centrifugal force produced by its rotation. Description of the velocity field within the rotating device was accomplished by application of the theory of plasticity. The first step in computing the velocity field was the determination of the associated stress field. When the stress field had been determined it was possible to solve a second set of differential equations derived from continuity requirements and the flow rule associated with this yield function to obtain the velocity field. Major conclusions are that the present computer technology is sufficient to allow the numerical integration of the equilibrium and flow equations in cases somewhat more complicated than the gravity flow cases previously treated. Dissert. Abstr.

N68-26165 California Univ., Berkeley.
AN INVESTIGATION OF THE COMPRESSIBLE LAMINAR WAKE BEHIND A LONG SLENDER CYLINDER
Robert Hung Cinn Au (Ph.D. Thesis) 1966 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8515

A theoretical and experimental investigation of the compressible laminar wake behind a long slender cylinder has been made. The theoretical investigation has led to approximate solutions which are valid within the entire wake region extending from the rear stagnation point. Solutions for two-dimensional and axially symmetric flows are obtained from the momentum and energy equations which are linearized on the basis of centerline properties. A sample calculation for the profiles in the near wake was made. An experiment to produce a thick laminar compressible wake behind a long thin circular cylinder was devised. The free stream Mach number and Reynolds number were 4.02 and 2300/inch, respectively. The electron beam-fluorescence technique was used to obtain the density and rotational temperature profiles for stations extending from a half diameter to 42 diameters downstream from the base of the cylinder. Impact pressures were also obtained at these stations. Measurements in the separated region indicated the existence of large gradients in static pressure. Dissert. Abstr.

N68-26179 Brown Univ., Providence, R. I.
EQUATIONS FOR GAS MIXTURES WITH APPLICATION TO THE STUDY OF SHOCK STRUCTURE IN A BINARY GAS
Edward Ben Goldman (Ph.D. Thesis) 1966 84 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-2241

A closed set of equations is obtained for arbitrary gas mixtures. Component conservation equations are obtained by taking moments of the Boltzmann equations associated with the mixture. The momentum and energy transfer integrals that arise are evaluated and written in terms of differences in velocities and temperatures. Composite conservation equations are written for the mixture, and expressions for the composite energy, stress, and heat conduction are found. In this study, we present a perturbation method which holds generally for any type of gas mixture. We perform that portion of the Chapman–Enskog procedure that must be performed in any normal solution of a gas mixture. After expressions are found for the orders of magnitude of the various length scales, it is shown that only two possible theories follow from a generalized Chapman–Enskog procedure. The structure of a shock wave in a binary mixture is studied using the general two fluid equations. After a suitable normalization, the equations are solved by a perturbation method employing expansions in terms of a shock strength parameter. Dissert. Abstr.

N68-26182 Michigan Univ., Ann Arbor.
NOISE CHARACTERISTICS OF CONVERGENT CROSS-FIELD SPACE-CHARGE FLOWS
Shreedhar Govind Lele (Ph.D. Thesis) 1966 285 p
Available from Univ. Microfilms: HC $12.85/MF $3.70 Order No. 67-8295

The purpose of this study is to investigate the noise transport characteristics of space-charge flows in crossed d-c electric and magnetic fields. The theoretical work consists of a Monte Carlo analysis of the noise characteristics of Kino-type electron guns. The experimental studies are concerned with the detection and control of signal (noise) transport along the beams in these guns. An IBM-7090 high-speed digital computer is used to simulate random electron emission from the cathode and the subsequent space-charge flows in the gun and drift regions. Kinetic noise-voltage and noise-current fluctuations are considered only in the direction of the d-c beam velocity at each point in the beam. Ψ, the Self-power Density Spectrum (SPDS) of the noise-current fluctuations, and ϕ, the SPDS of the kinetic noise-voltage fluctuations, are calculated on a cross-sectional and a rectangle basis to study their variation along the beam and over a given beam cross section respectively. A significant change in the values of the noise parameters at a given beam cross section is found to occur in the neighborhood of the hybrid frequency for that region of the beam. An r-f probe technique was used to study signal (noise) transport in crossed-field guns. Dissert. Abstr.

N68-26188 Brown Univ., Providence, R. I.
THE RAYLEIGH PROBLEM IN A RADIATING COMPRESSIBLE GAS FOR FINITE PLATE MACH NUMBER
Alexander Solan (Ph.D. Thesis) 1966 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-2292

The flow of a compressible, viscous, heat-conducting, radiating gray gas near a flat plate set impulsively in motion in its own plane is considered and solved in certain limiting cases. The problem is formulated for general values of the Boltzmann number Bo (convection-radiation ratio). The plate Mach number is assumed to be sufficiently large so that a significant amount of heat is generated by dissipation. Asymptotic expansions are made for large ratio of the photon to molecular mean free path, N, taking into account

the effect of Bo. In the limit $N \to \infty$, with Bo finite and plate temperature equal to the temperature of the gas at rest, the asymptotically optimal scalings split the problem into an optically thin, compressible, viscous boundary layer with radiative emission but no self-absorption and an optically finite, inviscid, acoustic flow with full radiative interaction. It is found that the velocity profile in the boundary layer is only weakly affected by radiation. In the inviscid region an acoustic wave, generated by the absorption of radiation emitted from the boundary layer and by the transverse velocity, propagates normal to the plate and is dispersed by long-range radiative interaction. Dissert. Abstr.

N68-26204 California Inst. of Tech., Pasadena.
QUASI TWO-DIMENSIONAL FLOWS THROUGH CASCADES
Ramani Mani (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-8458

A thin airfoil theory is developed for an airfoil which spans the gap between a pair of stream surfaces which are slowly diverging or converging, in order to predict, theoretically, the effect of varying axial velocity on cascade performance of axial flow compressor rows. The procedure involves, firstly, derivation of approximate equations satisfied by suitably defined average potentials and stream functions in such quasi two-dimensional flows. The flow is assumed to be inviscid, irrotational, and incompressible, but the quasi two-dimensional type equations also result from less restrictive assumptions. Next, fundamental solutions to these equations, corresponding to bound, line sources and vortices, are found. A distribution of such solutions is used to formulate the airfoil problem. The vorticity distribution appears as the solution to a singular integral equation, which is solved by an approximate method. Dissert. Abstr.

N68-26227 North Carolina State Coll., Raleigh.
EFFECT OF DOWNSTREAM GEOMETRY ON RAREFIED GAS FLOW THROUGH A NOZZLE
Lalji Jayantilal Pavagadhi (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7429

The mass flow rate of nitrogen gas through a 3° divergent nozzle made from a short bellmouthed tube was measured along with the wall static pressure distribution to study the effect of downstream geometry on the throat flow. Unlike all the previous work, the flow rate and pressure distribution data were measured under steady-state and predetermined upstream conditions. The mass flow rate data were normalized with respect to one-dimensional, isentropic flow. The coefficient of discharge is plotted against the Reynolds number based on throat conditions and also plotted against the stagnation pressure. The mass flow rate varies with the pressure difference across the nozzle in the transition regime, the ratio of upstream-to-downstream pressure is used as a parameter for the variation of the discharge coefficient against Reynolds number and upstream pressure conditions. The results indicate that if the tube is opened as much as the displacement thickness, the mass flow rate increases. Opening of the tube beyond the displacement thickness has little effect on the mass flow rate through the throat. Dissert. Abstr.

N68-26228 Cornell Univ., Ithaca, N. Y.
STRUCTURE OF STRONG SHOCK WAVES
Ira Milton Scholnick 1967 66 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-9198

A model for the structure of strong shock waves is proposed which explicitly accounts for the existence of a near molecular beam, hypersonic flow upstream, and of a continuum, subsonic flow downstream. This is accomplished by considering the conversion of the beam into the continuum through collisions. Appropriate continuum equations are derived including the input of mass, momentum, and energy from the beam particles. The particles in the molecular beam are assumed to be converted into members of the continuum in a single collision; and the collision transport phenomena associated with the continuum are assumed to be governed by the Chapman–Enskog expressions. Comparisons with other models for shock structure and with experimental results are included. Upstream, the present model agrees with the Mott–Smith theory while downstream there is agreement with the Navier–Stokes results. Dissert. Abstr.

N68-26229 California Inst. of Tech., Pasadena.
EXPERIMENTAL INVESTIGATION OF SUPERSONIC LAMINAR, TWO-DIMENSIONAL BOUNDARY LAYER SEPARATION IN A COMPRESSION CORNER WITH AND WITHOUT COOLING
John Eldon Lewis (Ph.D. Thesis) 1967 141 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-8457

An experimental investigation of the boundary layer separation associated with a compression corner was conducted in a Mach 6 wind tunnel, and a supplementary study was performed in supersonic wind tunnel. Special emphasis was placed on the development of a wind tunnel model which approximated true two-dimensional flow, and which could be run in either a highly cooled or an adiabatic configuration. The basic measurements consist of the model surface pressure and temperature, and Pitot surveys of the boundary layer. The surface pressure distributions for the adiabatic wall configurations are compared with the theory of Lees and Reeves. The surface pressure distribution for the cold wall was compared with the adiabatic configuration for a laminar interaction, and the dependence on Reynolds number for both laminar and transitional interactions are observed. The free interaction similarity suggested by Chapman is empirically tested. The scaling suggested by Curle was tested also. Dissert. Abstr.

N68-26233 Louisiana State Univ., Baton Rouge.
TRANSLATIONAL OSCILLATION OF CYLINDERS AT HIGH AMPLITUDES IN LIQUID HELIUM 2
Devron Paul Thibodeaux (Ph.D. Thesis) 1967 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8800

Measurements have been made of the period and the logarithmic decrement of pairs of cylinders oscillating at high amplitude in liquid helium II between 2.17°K and 1.2°K. Both of these quantities are found to be constant for amplitudes less than a critical amplitude A_c which can be expressed by $A_c = 1.12 (a^2 \tau \nu_{eff})^{1/4}$ where a is the cylinder radius, τ is the period of oscillation, and ν_{eff} is an effective kinematic viscosity which is set equal to the kinematic viscosity of the normal fluid (ν_n) close to the lambda point, but is a very weak function of temperature. At amplitudes greater than A_c there is an increase in the log decrement and a decrease in the period which correspond to changes in the added mass coefficient k and the damping coefficient k'. The interaction between the two fluids is characterized by the weak temperature dependence of ν_{eff} and by an effective density ρ_{eff} introduced to make $\Delta k'$ and Δk independent of temperature. This ρ_{eff} is found to be independent of amplitude, which shows that the fraction of superfluid involved is not dependent on velocity; however, the fraction of superfluid which contributes to ρ_{eff} is found to be inversely proportional to the period τ. Dissert. Abstr.

N68-26327 Cornell Univ., Ithaca, N. Y.
THE STRUCTURE OF A WEAK SHOCK WAVE UNDERGOING REFLECTION FROM A WALL

Martin Bernard Lesser (Ph.D. Thesis) 1966 68 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-1475

The Navier–Stokes equations are used to study the unsteady viscous structure of a weak shock wave reflecting from an infinite plane wall. Both an adiabatic and an isothermal wall are considered. Incident and reflected shock solutions are expanded in asymptotic series in the shock strength; the first-order terms are shown to satisfy equations analogous to Burgers' equation. It is shown that to first order the same expansions can be obtained from either a generalization of Burgers' equation, which takes account of both directions of wave motion, or the Navier–Stokes equations. Second-order results in the reflection region are also obtained from the generalized Burgers' equation. These second-order results show the imbalance between the convective and diffusive effects which occurs during the reflection process. The isothermal wall solution shows that viscosity and convection play a secondary role compared to the wall temperature boundary condition in determining the structure of the reflected shock wave. Author

N68-26362*# California Inst. of Tech., Pasadena. Karman Lab. of Fluid Mechanics and Jet Propulsion.
EXPERIMENTAL STUDY OF CAVITATING HYDROFOILS IN CASCADE Final Report
A. J. Acosta and R. B. Wade Feb. 1968 131 p refs
(Grant NGR-05-002-059)
(NASA-CR-95098) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Water tunnel experiments were conducted on a cavitating cascade of flat plate hydro-foils with a mean stagger angle of 45° and a solidity of one. The blade profile was in essence that of a biconvex airfoil with a thickness percentage of 8%. Attention centered on the time average values of the forces on the blades of the cascade, the angular change of the flow as it passes through the cascade, and the existence of any naturally-occurring unsteady phenomena of the cavitation process. Steady and unsteady measurements were made, and high-speed motion pictures were taken for various operating conditions. The data reduction procedures are outlined. It was found: (1) When cavitation commenced at the leading edge, the cavitation process became unstable and fluctuated with a frequency dependent on the angle of attack and the mean cavity length. When the cavities were a quarter chord or so greater than the hydrofoil, these oscillations ceased and the flow became essentially steady. (2) The condition of maximum lift on the hydrofoil occurred when the mean cavity length was about one chord in length; this corresponded to the fluctuations of maximum intensity. M.G.J.

N68-26363*# Maryland Univ., College Park. Dept. of Chemical Engineering.
[CRITICAL EVALUATION AND COMPILATION OF VISCOSITY AND DIFFUSIVITY DATA] Semiannual Status Report, 1 Nov. 1967–30 Apr. 1968
R. B. Beckman 1968 20 p refs
(Grant NGR-21-003-053)
(NASA-CR-94965) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An overview is presented on the data logging and retrieval system developed to permit the critical evaluation of molecular diffusion coefficients. In the system, solvent and solute names are codified, with the following data logged for each system: solute and solvent designation and names temperature, solute concentration, diffusion coefficient, type of diffusion coefficient and method of measurement, precision, literature reference for the diffusion coefficient, the viscosity values for the system, and the reference for the viscosity value. A sample of the indexing procedures and a typical printout are included. M.G.J.

N68-26405# National Bureau of Standards, Washington, D. C.
TABLES OF COLLISION INTEGRALS FOR THE (M, 6) POTENTIAL FOR TEN VALUES OF M
Max Klein and F. J. Smith (Queens Univ., Belfast) Arnold AF Sta., Tenn. Arnold Eng. Develop. Center May 1968 78 p refs Sponsored by AF
(AEDC-TR-68-92; AD-668433)

Tables of collsion integrals are presented for the (m, 6) potential function for 87 reduced temperatures for each of 10 values of m. The exponents m used were m = 9, 12, 15, 18, 21, 24, 30, 50, and 75. Comparisons are made with five other calculations for the case m = 12. The accuracy of the calculation appears to be at least several parts in 10,000. Author (TAB)

N68-26412# Aerospace Corp., El Segundo, Calif.
MERGED STAGNATION SHOCK LAYER OF NONEQUILIBRIUM DISSOCIATING GAS
Paul M. Chung, James F. Holt, and Shaowen W. Liu Jan. 1968 47 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-10)-8; SAMSO-TR-68-143; AD-668442)

The paper presents the formulation of the problem, the numerical method leading to solution, and the physical significance of the results obtained for the fluid flow of a viscous merged layer with nonequilibrium chemical reactions. The solution is limited to the stagnation region of a blunt body. The chemical reactions considered are the dissociation and the recombination of air. It is first shown that the reduced Navier-Stokes equation and the corresponding energy and species conservation equations, wherein certain curvature effects have been neglected, are sufficiently accurate for the flow regime in which Re > or approx. 20, where Re is the Reynolds number behind the bow shock. It is also shown that only in this regime are the nonequilibrium chemical reactions important. From the solutions it was found, as was expected, that a strong coupling exists between the chemical reactions and the rarefaction of the shock layer. One of the unexpected results is that, for a given flight condition, increase of the surface catalycity causes the shock layer to become thinner. Since the increase in surface catalycity reduces the degree of dissociation within the merged shock layer, it had been expected that it would increase the shock layer thickness instead of decreasing it. The physical interpretation of the phenomenon and its possible implications are discussed. Author (TAB)

N68-26441# Naval Ordnance Lab., White Oak, Md.
SOLUTIONS OF THE SECOND-ORDER BOUNDARY-LAYER EQUATIONS FOR LAMINAR INCOMPRESSIBLE FLOW
Michael J. Werle 31 Jan. 1968 192 p refs
(NOLTR-68-19; AD-668498)

Use is made of self similarity approach and integral momentum technique to obtain solutions of Van Dykes second-order boundary-layer equations for laminar incompressible flow. Accurate numerical solutions of the most general self similar equations are tabulated for the four second-order contributions due to vorticity interaction, displacement speed, longitudinal curvature, and transverse curvature. A limited number of closed form solutions are obtained which appear to have special significance at the point of first-order boundary-layer separation. In particular it is found that the displacement speed problem can proceed up to separation for only two values of the second-order pressure gradient. All other cases display an infinite discontinuity at this point. Numerical solutions of a large number of cases for the longitudinal and transverse curvature effects well support an identical conclusion. The integral momentum technique applied (a straight forward extension of the Karmen-Pohlhausen solutions) is found to be oversensitive to approximations and in the final analysis is rejected in favor of locally similar solutions. Author (TAB)

N68-26470# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

INVESTIGATION OF A VORTEX WAKE BEHIND A BODY OF REVOLUTION

E. K. Buchinskaya and K. A. Pochkina 28 Feb. 1968 27 p refs Transl. into ENGLISH from Prom. Aérodinamika (USSR), no. 27, 1966 p 121–144

(Contract NOw-62-0604-c)

(TG-230-T546; AD-667999)

Results are given of an experimental study of the structure of a vortex wake behind a thin body of revolution at different angles of attack. Wake measurements were carried out in a closed wind tunnel at a flow velocity corresponding to a Reynolds number of 4,300,000 and angles of attack of 0, 10, 20 and 30 degrees. The total, dynamic and static pressures were measured in various sections behind the body. The dimensionless velocity and coefficients of static and total pressure were calculated from these measurements. Author (TAB)

N68-26528*# Alabama Univ. Research Inst., Huntsville.

HYDRAULIC CHARACTERISTICS OF SPATIALLY VARIED FLOW IN A TRAPEZOIDAL CHANNEL

Cornelius C. Shih and Saeed Mirza [1967] 25 p refs Presented at the Intern. Conf. on Hydraulic Res., Brno, 3–5 Oct. 1967

(Grant NsG-381)

(NASA-CR-87688) CFSTI: HC $3.00/MF $0.65 CSCL 20D

This study is concerned with the hydraulic characteristics of spatially varied flow in an open channel with an increasing discharge and a free over-fall at the down stream end. The dynamic equation of the flow, derived from the principle of momentum conservation, is expressed in dimensionless form, and is applied for the analysis of four possible flow profiles and the locations of control flow section. The non-dimensional equation is made applicable to channels of trapezoidal, rectangular, and triangular shapes. The effect of lateral inflow upon the flow characteristics was taken into consideration in the derivation of the equation. Solutions of the equation were obtained by the numerical method with the use of an electronic digital computer. Results of the theoretical analysis are in agreement with the experimental results obtained from the tests on a trapezoidal flume, which were conducted for the purpose of verification of the theory. Author

N68-26539 California Univ., Berkeley.

THE EFFECT OF AIR COMPRESSIBILITY IN THE IMPACT OF A FLAT BODY UPON A FREE SURFACE

Robert Steward Johnson (Ph.D. Thesis) 1966 179 p

Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-8506

It has been suggested that the high pressures exerted on the bottom of a ship's hull during slamming are developed in the air trapped between the hull and the water's surface. To test this hypothesis, the two-dimensional, unsteady problem of the flow of air, where compressibility is accounted for, between a rigid, flat-bottomed block falling towards a rigid plane, is solved using a numerical method. The computed pressures exceeded those found experimentally by Maclean and it is concluded that the deformation of the water's free surface must be accounted for in order to obtain agreement with the experiment. To the author's knowledge, the numerical method, a modified version of Sauer's method of Near Characteristics, is applied here for the first time. Author

N68-26574# Aerospace Corp., El Segundo, Calif. Plasma Research Lab.

EVAPORATION OF A DROPLET IN FREE MOLECULAR FLOW Documentary Research Report, Sep. 1966–Nov. 1967

Kenneth P. Horn, Vladislaw Bevc, and Marc A. Kolpin Feb. 1968 20 p refs

(Contract F04695-67-C-0158)

(SAMSO-TR-68-146; TR-0158(3220-10)-5; AD-668445)

The problem of the evaporation of a moving spherical droplet in free molecular flow is studied. An exact solution for the reduction in the droplet size is derived by use of the free molecular limits for drag coefficient and modified Stanton number. An approximate solution is also presented that reduces the complexity of the velocity dependence in the heat transfer relation. Good agreement between the two solutions is demonstrated for a wide range of freestream temperatures. One particular case, using water as the droplet medium, is examined under reentry conditions. Author (TAB)

N68-26651*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DETAILED PERFORMANCE OF A RADIAL-BLADED CENTRIFUGAL PUMP IMPELLER IN WATER

Max J. Miller and Richard F. Soltis Washington Jun. 1968 52 p refs

(NASA-TN-D-4613) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Shrouded and unshrouded versions of a 7.44-in.-(18.89-cm-) diameter, radial-bladed centrifugal pump impeller were tested in room-temperature water. Detailed measurements permitted the calculations of both circumferential and spanwise distributions of flow and performance parameters over a wide range of flows. Primary emphasis is on essentially noncavitating flow conditions, although a limited amount of performance data obtained under cavitating flow conditions is presented. Author

N68-26696# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.

INVESTIGATION OF THE WAKE BEHIND A CYLINDER AT COINCIDENCE OF A NATURAL FREQUENCY OF VIBRATION OF THE CYLINDER AND THE VORTEX SHEDDING FREQUENCY

Charles L. Ballou (Ph.D. Thesis) 19 May 1967 45 p refs

(Contract Nonr-3963(25))

(Rept.-76028-2; AD-668170)

Experimental results of the investigation of the wake behind a cylinder shedding vortices at a frequency that was the same as a natural vibrational frequency of the cylinder are presented. The lateral spacial correlation of vortex shedding, the distance behind the cylinder, and the value of RMS velocity at the assumed position where the vortices start to roll up were found not to deviate from the normal trend with respect to Reynolds number when coincidence of the two frequencies occur. Author (TAB)

N68-26715# Colorado State Univ., Fort Collins. Fluid Mechanics Program.

A LABORATORY STUDY ON THE DRAG FORCE DISTRIBUTION WITHIN MODEL FOREST CANOPIES IN TURBULENT SHEAR FLOWS

G. Hsi and J. H. Nath Mar. 1968 72 p refs

(Contract DA-AMC-28-043-65-G20)

(CER67-68GH-JHN50; AD-668255)

The objective of this study was to determine distribution of the tree drag force within various model forest canopies subjected to various ambient wind conditions. Ultimately this information may be related to diffusion within the forest canopy. The influence on individual tree drag due to neighboring trees was investigated by arranging the trees in various configurations of columns and rows, the columns being parallel to the ambient wind and the rows being perpendicular. Two tree spacings for the columns and rows were investigated. Furthermore, a large forest canopy field was investigated that covered an area of twenty-one square meters. For this arrangement it was determined that the tree drag field can

be classified into two zones - an initial zone and a steady decay zone. In order to study the influence of the boundary layer development on tree drag, the various arrangements of trees were tested under a thin boundary layer condition and under a thick boundary layer condition. In the course of this study a strain gage force dynamometer was developed that can reliably measure a drag force as small as 0.1 gram on a model tree. Author (TAB)

N68-26773# Naval Ship Research and Development Center, Washington, D. C. Hydromechanics Lab.
OSCILLATION OF CYLINDERS IN OR BELOW THE FREE SURFACE OF DEEP FLUIDS
Werner Frank Oct. 1967 50 p refs
(NSRDC-2375; AD-668338)

The subject of cylinders oscillating in or below the free surface of very deep fluids is developed as a boundary value problem within the framework of linear free-surface theory by distributing source singularities over the submerged portion of the cylinders. A computer program for calculating the hydrodynamic pressure, force, and moment of fluids on these cylinders was devised. The results for various two-dimensional shapes are given in graphical form. Author (TAB)

N68-26782# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OSCILLATIONS OF AN ELASTIC PLATE IN A FLUID [KOLEBANIYA UPRUGOY PLASTINKI V ZHIDKOSTI]
A. S. Povitskiy 29 Aug. 1967 12 p ref Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Aviats. Tekh. (Kazan), no. 4, 1958 p 30–35
(FTD-HT-66-790; AD-668018)

The two-dimensional problem of an oscillating elastic plate is discussed, the plate being either of a constant or of a variable thickness and in contact with the free surface of the ideal liquid (the case of a submerged plate may be obtained from the above by a duplication of the corresponding coefficient). Only free natural frequencies are considered, and especially the first mode of oscillation. Author (TAB)

N68-26787*# Massachusetts Univ., Amherst. Dept. of Mechanical and Aerospace Engineering.
EFFECTS OF COMPRESSIBILITY AND VISCOSITY IN CURVED FLOWS
J. A. Fillo Sep. 1967 17 p refs Presented at the 5th Meeting, Soc. of Eng. Sci., Huntsville, Ala., Oct. 1967
(Grant NGR-22-010-019)
(NASA-CR-88604) CFSTI: HC$3.00/MF$0.65 CSCL 20D

A brief survey of the status of curved flows reveals that the problems which have been investigated pertain either to a small shear, large disturbance approximation or a large shear, small disturbance approximation. While there is some experimental evidence that confirms the applicability of such solutions in incompressible flow, it appears that linearized solutions can be improved upon in more general cases by the use of local similarity techniques. The local similarity solution is discussed both for the general singular perturbation problem as well as for some practical curved duct flows. Author

N68-26830*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A STUDY OF THE TRANSIENT FLOW FIELD AHEAD OF A SPHERE WHICH HAS BEEN STRUCK BY A NORMAL SHOCK WAVE
Richard W. Barnwell [1967] 21 p refs Presented at the 10th Midwestern Mech. Conf., Ft. Collins, Colo., 21–23 Aug. 1967
(NASA-TM-X-60415) CFSTI: HC$3.00/MF$0.65 CSCL 20D

Numerical results are presented for the normal shock wave–sphere interaction problem for perfect- and real-gas flow fields. A finite difference method is used to solve the governing flow equations. The differencing technique which is employed is a modification to the technique developed for treating inviscid, unsteady one-dimensional flow fields containing embedded shock waves. Results are presented for the unsteady behavior of the shock detachment distance and the stagnation-point pressure. The cases which are treated cover wide ranges of the ratio of specific heats and the incident shock Mach number. The results show that the growth of the shock layer thickness is much slower than the adjustment of the stagnation point pressure to its steady value. Author

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N68-25678*# Arizona Univ., Tucson.
THE PROBLEM OF NEGATIVE INDUCED POLARIZATION ANOMALIES
John S. Sumner [1967] 20 p refs Presented at the Symp. on Induced Polarization, Berkeley, Calif., 18–19 Feb. 1967
(Grant NGR-03-002-091)
(NASA-CR-87684) CFSTI: HC$3.00/MF$0.65 CSCL 08G

The cause and characteristics of the negative induced polarization (IP) effect are discussed from the viewpoint that the negative effect is not actually a property of rocks but is due to an interaction of the geometry of polarizable bodies and measuring electrode positions. Positive and negative IP decay waveforms in the time domain are depicted, along with possible types of decay waveforms. The point is made that in some field circumstances positive and negative curves will possibly combine, either resulting in cancellation of the IP effect or in the production of composite curves. The response of a simple equivalent circuit is reviewed to show the electrical parameters that effect the induced electrical polarization of a material. A model of a polarized sphere is used to further explain the phenomena, and it is seen that the negative effects can be quite large. The results indicate that composite waveforms can exist if positive and negative decays with different time constants combine algebraically. M.G.J.

N68-25713*# Rice Univ., Houston, Tex. Dept. of Space Science.
THE MUTUAL EFFECT OF PRECIPITATED AURORAL ELECTRONS AND THE AURORAL ELECTROJET
Bernt N. Maehlum and Brian J. O'Brien [1967] 18 p refs Presented at the IUGG Gen. Assembly, St. Gall (Switzerland), Sep. 1967
(Contract NAS6-1061; Grant NsG-675)
(NASA-CR-88054) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The perturbation in the geomagnetic field produced by the electrojet also affects the pitch angle distribution of the precipitated electrons chiefly responsible for the auroral ionization within which it is assumed the electrojet flows. To study this interaction, a computer program was developed for model calculations which computes: (1) electron density profiles in the ionosphere from a given pitch angle and energy distribution of the ionizing electrons; and (2) changes in pitch angle distribution created by geomagnetic field deformations caused by the electrojet current itself. Preliminary results are discussed. The interaction can cause significant time variations in an initially time-stationary electron precipitation event. For the first time it is shown that naturally occurring atmospheric feedback effects can account for dynamic auroral variations without requiring the auroral source itself to vary in time. The variations

are governed by pitch angle distribution, total flux of precipitated electrons, and by the normal loss parameters in the upper atmosphere. For medium to strong precipitation events the calculated periodicity of the variations ranges from 50 to 200 seconds, which agrees with some observed periodicities. Author

N68-25719*# Rice Univ., Houston, Tex. Dept. of Space Science.
HYDROGEN EMISSION IN PULSATING AURORAS
R. H. Eather [1967] 29 p refs Presented at the Birkeland Symp. on Aurora and Magnetic Storms, Sandefjord, Norway, Sep. 1967
(Grant NsG-673)
(NASA-CR-88231) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Simultaneous measurements of electron-excited emissions and Hβ emission during three pulsating auroras (5–15 second period) showed no detectable Hβ pulsations. An upper limit for any Hβ modulation is about 1/8 the percentage modulation of the electron-excited emission. If this result is true in general, it limits possible pulsation mechanisms to those involving plasma instabilities. A single observation of a pulsating aurora with a 50–200 second period is also reported; both Hβ and electron-excited λ5577 OI were modulated to the same extent. It is believed a different mechanism was responsible, possibly loss-cone modulation by hydromagnetic waves near the equatorial plane. Author

N68-25720*# Rice Univ., Houston, Tex. Dept. of Space Science.
SOME RECENT RESULTS ON THE MEASUREMENT OF HYDROGEN AND HELIUM EMISSIONS IN THE AURORAL ZONE
R. H. Eather [1967] 20 p refs Presented at the Birkeland Symp. on Aurora and Magnetic Storms, Sandefjord, Norway, Sep. 1967
(Grant NsG-673)
(NASA-CR-83315) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A photometric scanning system with a sensitivity of 0.05 R/A failed to detect any λ5876/HeI emission in the auroral zone. An emission feature in this region was found to be part of the 8-2 hydroxyl system. Upper limits of 0.02 to 0.003 are placed on the λ5876/Hβ ratio and the corresponding α-particle/proton ratios are calculated as functions of particle energy. The ratios of the intensity of λ3914 N_2^+, λ4709 N_2^+, λ5577 OI and λ6300 OI to the Hβ intensity have been measured in proton-excited auroras. The ranges in measured ratios (described by one standard deviation from the mean) are 10.0 to 17.5, 0.9 to 1.3, 9.0 to 12.5 and 2.5 to 3.3 respectively; and these are in reasonable agreement with theoretical predictions. Recommended values to use for the ratios are 17.0, 1.0, 10.0 and 3.0 respectively. The results may be used to estimate the relative importance of proton and electron excitation in auroras. Author

N68-25756*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LATITUDINAL VARIATION OF THE COMPOSITION OF THE TOPSIDE IONOSPHERE; FIRST RESULTS OF THE OGO-2 ION SPECTROMETER
H. A. Taylor, Jr., H. C. Brinton, M. W. Pharo, III, and N. K. Rahman May 1968 43 p refs
(NASA-TM-X-63221; X-621-68-202) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Direct measurements of a pronounced latitudinal variation in the exospheric ion composition have been obtained from a radio frequency ion spectrometer experiment. Measurements of thermal positive ions show that in the altitude range of 415 to 1525 kilometers the major ions are O^+ and H^+. Evidence of pronounced solar and geomagnetic control of the ion distributions is further examined by translating the data along magnetic field lines to both a constant 1000 kilometer reference level and the dipole equator. The high latitude ionosphere is marked by two dominant features. First a major trough in $n(H^+)$ and $n(He^+)$, and secondly a variable poleward peak in which the total ion concentration, N_i, approaches 10^4 ions/cm^3 near 80 degrees dipole. The pronounced light ion trough, which correlates well with the whistler cutoff, is believed to mark the high latitude boundary of the thermal plasma. That the polar exosphere is decoupled from the plasmasphere and is probably linked with the solar wind-magnetospheric tail system is also suggested. Author

N68-25763# Advisory Group for Aerospace Research and Development, Paris (France).
SURVEY ON THE MEASUREMENTS OF THE TOTAL ELECTRON CONTENT VARIATION BY MEANS OF GEO-STATIONARY SATELLITE TRANSMISSION
R. S. Allen (AFCRL) and P. F. Checcacci (Centro Microonde, Florence) 1967 23 p
(AGARD-559) CFSTI: HC $3.00/MF $0.65

Current methods of using the Atlantic synchronous satellite, Early Bird, are described and the total electron content and scintillation results obtained by a cooperative association of laboratories, the Joint Satellite Studies Group, is given. Ionospheric information can now be obtained by direct measurement instead of by estimation from data extrapolated from several sources, and diurnal and seasonal variations at individual stations can be studied by continuous observation. Author

N68-25771*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
STUDY OF FLOW FIELDS IN THE TRANSITIONAL REGIME AND THEIR EFFECTS UPON AERONOMY MEASUREMENTS Final Report
L. E. Golden 17 May 1968 82 p refs
(Contract NAS5-11016)
(NASA-CR-94922; AED-R-3288) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Methods are described for calculating the properties of the fluid flow fields produced by a rocket or satellite moving through the upper atmosphere at altitudes of 100 to 150 kilometers, and preliminary information on the trends and magnitudes of the parameters affecting data interpretation. Computer programs based on a Monte Carlo procedure and the perturbation method for calculating the properties of these fluid flow fields, are discussed. Limited information obtained by these computations indicates that the flow field can have a very great effect on interpretation of data obtained from instruments of high speed vehicles. Results show that there is a significant increase in the flux to the body in the vicinity of the stagnation point. The present work has demonstrated operationally that the transition regime flow field studies are accessible by the Monte Carlo method. A.L.

N68-25774*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE UPPER ATMOSPHERE AS A MULTIPLE REFRACTIVE MEDIUM FOR NEUTRAL AIR MOTIONS
Hans E. Volland May 1968 45 p refs
(NASA-TM-X-63224; X-621-68-160) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Under the influence of gravity and heat conduction four plane characteristic waves obliquely incident on a horizontally stratified atmosphere can propagate, two of them upward and the two other downward. The two pairs of characteristic waves are the well known acoustic-gravity waves and the heat conduction waves. Molecular viscosity generates two further pairs of characteristic waves, the ordinary and the extraordinary viscosity waves. Ion drag and Coriolis force make the atmosphere anisotropic with respect

to the characteristic waves. Their propagation characteristics for east to west and north to south propagation differ from each other. Some analytical solutions of the eigenvalues of these eight characteristic waves are given in this paper. Numerical calculations of the eigenvalues depending on the parameters of the thermosphere, on frequency, azimuth and on angle of incidence are presented and discussed in some detail. Author

N68-25776*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

FULL WAVE CALCULATIONS OF THERMOSPHERIC NEUTRAL AIR MOTIONS

Hans E. Volland May 1968 50 p refs

(NASA-TM-X-63227; X-621-68-176) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Full wave calculations have been performed within the frequency range of gravity waves ($10^{-4} \leq \omega \leq 10^{-2}$ sec^{-2}) for a thermospheric model between 120 and 700 km altitude. In this altitude range gravity waves are coupled with heat conduction waves. Reflection, transmission, conversion and coupling from one wave type into the other one is described by the elements of the scattering matrix. The dependence of these elements on frequency and angle of incidence is discussed in full detail. The transmission coefficients of gravity waves calculated by full wave theory are compared with simple ray calculations and show that ray treatment is an excellent approximation for obliquely upward propagating gravity waves and that gravity waves predominate throughout the thermosphere. The thermosphere reacts like a selective filter with respect to upward propagating gravity waves with optimal transmission at $k_x \approx 2\omega$ (ω = angular frequency; k_x = horizontal wave number). Vertically downward propagating heat conduction waves are mainly converted into upward reflected gravity waves (at higher frequencies) or mainly coupled into downward propagating gravity waves (at lower frequencies). Author

N68-25822# Joint Publications Research Service, Washington, D. C.

SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 181

6 Jun. 1968 155 p refs Transl. into ENGLISH from various Russian articles

(JPRS-45575)

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N68-25825# Joint Publications Research Service, Washington, D. C.

OCEANOGRAPHY

In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 181 6 Jun. 1968 p 64-74 refs Transl. into ENGLISH from various Russian articles (See N68-25822 15-13)

Oceanographic news and scientific research activities in the Soviet bloc are summarized. Mention is made of a new trawler for the Pacific fleet, polar research in the North Atlantic, research vessel studies in the South Atlantic, and long distance transmission of hydrological data. A nonlinear model for the equatorial flow of an inhomogeneous fluid is presented, sediments and bottom currents are discussed, and temperature of the water surface and the active layer of the sea were measured. Other studies consider the space-frequency structure of the ocean swell, thermal conductivity of ocean waves, and the natural electrical field in the sea. In addition to summaries on uranium distribution is sea sediments and thoron exhalation, an asymptotic solution to two problems in satellite dynamics is included. The free central solid body in a free central Newtonian field is discussed, and two methods are given for optimizing stabilization rate. M.W.R.

N68-25826# Joint Publications Research Service, Washington, D. C.

TERRESTRIAL GEOPHYSICS

In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 181 6 Jun. 1968 p 75–101 refs Transl. into ENGLISH from various Russian articles (See N68-25822 15-13)

Soviet bloc news and research activities in terrestrial physics cover studies in geodesy, cartography, geology, and seismology. Mention is made of some new seismological devices and the minerals in the Antarctic mountains. Layered geoelectric structures, gravity and magnetic fields, wave forming at the Moho, and anisotropy in rocks are discussed. Determinations were made of the thickness of the earth crust, transverse reflected waves, secular variation for ocean areas, and surface waves. Theoretical curves for deep electromagnetic sounding were made, oriented magnetization of finely dispersed sediments were studied, and topology of the high latitude nighttime magnetosphere was reviewed. M.W.R.

N68-25827# Joint Publications Research Service, Washington, D. C.

UPPER ATMOSPHERE AND SPACE RESEARCH

In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 181 6 Jun. 1968 p 102–140 refs Transl. into ENGLISH from various Russian articles (See N68-25822 15-13)

Upper atmosphere and space research efforts of the Soviet bloc are reported in news items and abstracts of scientific articles. Several Kosmos launchings, aspects of docking and its complexity, and satellite studies and observation stations are noted. Auroral absorption, solar winds and flares, electron concentration in the ionosphere, radio wave absorption, and terrestrial radiation are among the topics of the scientific articles. Neutral and ionized atmospheric components, cosmic ray intensity, stability of satellite motions and optimal flight, and ionization drift are other topics. Also summarized are studies on vorticity in isotropic turbulence, plane optimal transfer between orbits, the Antarctic atmosphere, and flow of rarefied plasma. M.W.R.

N68-25828# Joint Publications Research Service, Washington, D. C.

MISCELLANEOUS

In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 181 6 Jun. 1968 p 141–144 refs Transl. into ENGLISH from various Russian articles (See N68-25822 15-13)

Several news and abstracts of scientific articles from the Societ open literature deal with a Soviet Antarctic expedition, Arctic Ocean drifting stations, and a Soviet Antarctic capital scheduled for 1970. Use of geodesy and aerial photography in Antarctic studies atmospheric processes in Antarctica, and geophysical problems are reviewed. M.W.R.

N68-25835# Joint Publications Research Service, Washington, D. C.

TEMPERATURE INHOMOGENEITIES IN THE SEA

S. V. Dobroklonskiy, S. F. Mirkotan, G. G. Khundzhua, and N. K. Shelkovnikov 14 Jun. 1968 14 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Atm. i Okeana (USSR), v. 4, no. 4, 1968 p 451–459
(JPRS-45681) CFSTI: HC $3.00/MF $0.65

The results of a study of temperature fluctuations in the sea by the correlation analysis method is presented. Statistical processing of the experimental data yielded the volume characteristics of temperature inhomogeneities in the sea. It was found that the inhomogeneities have an ellipsoidal form with axes a = 2.4 m, b = 0.9 m, and d = 0.7 m. The long axis of the inhomogeneities coincides with the direction of the drift velocity of the medium. The mean relaxation time is 1.8 second. Finally the instrumentation and research methods employed are discussed. Author

N68-25840# Danish Meteorological Inst., Charlottenlund.
DANISH VISUAL AURORA OBSERVATIONS, 1960–1966
Knud Lassen and O. Rud Laursen Jan. 1968 31 p refs
(R-2) CFSTI: HC $3.00/MF $0.65

Graphical data are presented on auroral observations made in Denmark during the period July 1960 through June 1966. This was a continuation of the International Geophysical Year program. Observations were supplemented by reports from climatology stations and amateur observers. Included are statistics on sunspot variation of observed numbers of auroral nights, annual variation of observed numbers of auroral nights, and daily variations of auroral frequency. Also included are tables listing the observations by day, month, and station. A.L.

N68-25921# Institute of Technology, Helsinki (Finland).
ON THE GEOPHYSICAL INVESTIGATION IN THE VIRTASALMI AREA
Toivo Siikarla (Ph.D. Thesis) 1967 87 p refs *Its* Dissertation No. 149 CFSTI: HC $3.00/MF $0.65

The geophysical investigation in the Virtasalmi area and the geological interpretation of the results obtained are discussed. Special attention is paid to gravity measurements in order to ascertain whether the methods, developed for gravimetric measurements and reduction on the basis of a survey carried out in small areas, could also be employed for the investigation of extensive areas. The physical properties of the rocks in the area investigated are described and a geological interpretation is given to the results of the geophysical measurements performed by various methods. Author

N68-26001# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
EVALUATION OF THE ACCURACY OF GRAVIMETRIC MAPS [OTSENKA TOCHNOSTI GRAVIMETRICHESKIKH KART]
M. V. Avdulov Feb. 1968 21 p refs Transl. into ENGLISH from Prikl. Geofiz. (Moscow), no. 36, 1963 p 167–180
(ACIC-TC-1363; AD-668177)

The accuracy of a map of gravity anomalies is understood to be the error in the determination of the anomaly at any point of the map, selected at random. The accuracy of a gravimetric map is determined by the error in the computations of the anomaly at the points of measurement and by the density of distribution of these points. This translation is a detailed analyzation of the problem of accuracy of gravimetric maps. Even though the suggested method of evaluation of accuracy was analyzed in connection with gravimetric problems, it can be used for the evaluation of the accuracy of maps compiled from magnetic survey data and in many cases a map compiled with the aid of a network of discrete values. Author (TAB)

N68-26038 California Univ., Los Angeles.
THERMAL HISTORY OF THE EARTH
William Hung Kan Lee (Ph.D. Thesis) 1967 64 p
Available from Univ. Microfilms: HC $16.45/MF $4.65 Order No. 67-9031

The plausible history of the earth's internal temperature distribution and surface heat-flow is investigated by comparing the results of model calculations with deductions based on observations. The hitherto neglected effect of moving heat sources is taken into account, and an unconditionally stable numerical method for solving the heat equation is introduced. Data pertinent to the earth's thermal history are reviewed and brought up-to-date. The earth's thermal state is inferred from its heat budget, internal structure, and thermal and electrical properties. Fifteen spherically symmetric models of the mantle were constructed to represent the possible range of thermal data and initial conditions. Two sets of calculations for each model were carried out to examine the effect of upward migration of radioactive elements. Dissert. Abstr.

N68-26069# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
DETERMINATION OF THE COMPOSITION OF ROCKS OF THE PALEOZOIC BASEMENT ACCORDING TO CHARACTERISTIC PECULIARITIES OF THE ANOMALOUS MAGNETIC FIELD [OPREDELENIYE SOSTAVA POROD PALEOZOYSKOGO FUNDAMENTA PO KHARAKTERNYM OSOBENNOSTYAM ANOMAL'NOGO MAGNITNOGO POLYA]
A. V. Glazunova Feb. 1968 18 p refs Transl. into ENGLISH from Izv. Akad. Nauk Turkm. SSR, Fiz.-Tekhn., Khim. i Geol. Nauk (Ashkhabad), no. 6, 1966 p 65–74
(ACIC-TC-1348; AD-668301)

The translation discusses at length, and shows with graphs and charts, the comparison of results of the aeromagnetic survey with drilling data. It is indicated that aeromagnetic investigations are effective in determining the material composition of rocks of the Paleozoic basement in a geologically closed area. The conclusions drawn from this work are as indicated: (1) Determination of the basement rocks should be carried out on the basis of physical properties of rocks and peculiarities of the anomalous magnetic field above open areas, where known Paleozoic complexes of rocks are exposed on the surface. (2) While dividing the Paleozoic basement rocks in terms of material composition it is necessary to consider the depth of occurrence of magnetic rocks which cause T anomalies. (3) On a geologically closed area an analysis of the anomalous magnetic field from the point of view of determining the composition of the Paleozoic basement should be carried out in combination with the gravimetric data. Author (TAB)

N68-26189 California Univ., San Diego.
ELECTRIC AND MAGNETIC FIELDS INDUCED BY OCEANIC TIDAL MOTION
Jimmy Carl Larsens (Ph.D. Thesis) 1968 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8156

The existence of a lunar semidiurnal variation (12.4206 hour period) induced by an oceanic source is demonstrated. These variations due to an oceanic source were found by comparing the sea floor, coastal, and island observations with simultaneous continental magnetic observations in order to remove the part of the variation due to an ionospheric source. These oceanic induced variations at the sea floor and coastal sites were found to agree remarkably well with computed tidal induced fields based on a model of the earth's electrical conductivity and a Kelvin wave model of the lunar semidiurnal tide along California. The agreement of the computations and observations suggest that these fields are induced by barotropic oceanic tidal motion and that the Kelvin wave is a reasonable model of the lunar semidiurnal tide along California. The observed oceanic induced vertical magnetic

field at San Miguel is found to agree qualitatively with computed tidal induced fields based on an island model. For neither of these model studies could the mantle conductivity be deduced from the observed tidal induced fields. Author

N68-26198# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A STUDY IN ACOUSTIC DIRECTION FINDING
Walter S. Nordquist, Jr. Nov. 1967 24 p refs
(ECOM-5165; AD-667916)

The azimuth to a gun probe launcher position from an acoustic array located approximately six miles distant was determined from the acoustic data associated with a series of seven firings. Application of a meteorological correction technique using rawinsonde data indicates that the azimuth may be corrected up to forty percent of the total error if the rawinsonde sounding is taken at the time of firing and decreases from that value at a rate which is a function of the stability of the air mass involved. Author (TAB)

N68-26201# Montana State Univ., Missoula. Dept. of Geography.
SEQUENTIAL STUDY OF DESERT FLOODING IN THE WHITE MOUNTAINS OF CALIFORNIA AND NEVADA
Chester B. Beaty Natick, Mass. Natick Labs. Jan. 1968 106 p refs *Its* ES-37
(Contract DA-19-129-AMC-987(N))
(TR-68-31-ES; AD-667978)

A field study of flood conditions in the White Mountains of California and Nevada was carried out during the period September 1966 to August 1967. The investigation was a follow-up to a similar study conducted in 1956-57. Flooding during the decade 1957-66 has produced significant changes in parts of the White Mountain landscape. One minor and two major debris flows occurred during the period, and minor snowmelt flooding was frequent. Flooding observed during the contract period was of the three types known to occur in the study area: wintertime, snowmelt, and cloudburst floods. Floods were observed in December 1966, May-June 1967, and July-August 1967. The observed and reconstructed behavior of floods in and near the White Mountains during the period 1957-66 was in accord with the indicated principles. Author (TAB)

N68-26248# Texas Univ., Austin. Electrical Engineering Research Lab.
EXCITATION OF HYDROMAGNETIC WAVES IN THE EARTH'S UPPER ATMOSPHERE BY SOURCES OF FINITE EXTENT
Howard D. Holden and Francis X. Bostick 1 Apr. 1968 85 p refs
(Contract Nonr-375(14))
(Rept.-146; AD-668332)

A boundary value problem based on a model of the earths upper atmosphere is posed, formulated and solved. A point source is included within the stratified model thus necessitating a full three-dimensional treatment. (This is often an unnecessary complication if one can assume incident plane waves, current sheets, or other sources infinite in extent). By formulating the problem in circular cylindrical coordinates, symmetrys are maximized and double integral inversions are avoided. Due to the earths static magnetic field, the ionospheric media are anisotropic and the wave equation reduces to a dyadic Helmholtz equation. Seto (1964) has shown this equation to be separable in cylindrical coordinates under certain conditions. This important contribution by Seto is reviewed, somewhat extended, and adapted to the problem at hand. The separation equations lead directly to a dispersion relation. Electromagnetic field ratios (sometimes called wave impedances for an E/H ratio) are derived for an incremental cylinder wave. The boundary condition requirements are satisfied for the layered media numerically by using computational matrices. The advantages and limitations of this method are described. This is followed by a discussion of the contour used in the numerical evaluation of the integral. The vertical inhomogeneities in electrical parameters encountered in the ionosphere are quite severe. To accurately represent a continuously varying medium with a series of homogeneous layers each layer must be relatively thin in terms of wavelength. TAB

N68-26273# RAND Corp., Santa Monica, Calif.
THE POSSIBLE INFLUENCE OF ADDITIONAL EVAPORATION FROM RESERVOIRS AND IRRIGATED TRACTS ON PRECIPITATION
A. S. Grigoryeva Apr. 1968 5 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ. (Leningrad), Issue no. 211, 1967
(P-3826; AD-668008)

It is shown that measures for the creation of reservoirs, and the irrigation and watering of lands, which are projected through 1980, will only slightly affect precipitation over large territories. TAB

N68-26283# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
PREDICTING DIFFUSION OF ATMOSPHERIC CONTAMINANTS BY CONSIDERATION OF TURBULENT CHARACTERISTICS OF WSMR
Frank V. Hansen Jan. 1968 40 p refs
(ECOM-5170; AD-667920)

The relationships between the turbulent intensities about the mean flow in the lowest layers of the atmosphere at White Sands Missile Range, New Mexico, and climatological data are discussed in terms of predicting the diffusion of contaminants into the atmosphere. If the turbulent fluctuations observed in the lower portion of the boundary layer are considered representative, then correlations with climatological summaries may be used as a rudimentary estimator for estimating the diffusion power of the atmosphere. A simple empirical diffusion model for general use is also given. Author (TAB)

N68-26288# Stanford Research Inst., Menlo Park, Calif.
GEOMAGNETIC DATA: BANGKOK, THAILAND Geophysical Data Report, Apr.-Jun. 1966
Douglas J. Barnes and John Chapman Jun. 1967 17 p
(Contract DA-36-039-AMC-00040(E); ARPA Order 371; SRI Proj. 4240)
(AD-667957)

Geomagnetic observations are being carried out at the Electronics Laboratory of the Military Research and Development Center, a joint Thailand-United States organization at Bangkok, Thailand. The data contained are obtained with a Varian V-4938A rubidium magnetometer. The data base is available in two forms: (1) the continuous magnetogram recording and (2) a digital printout every 2 minutes, both measuring the total geomagnetic field intensity. Author (TAB)

N68-26297# Army Natick Labs., Mass. Earth Sciences Lab.
A GENERAL MONOGRAPH FOR NORMAL AND SKEWED FREQUENCY DISTRIBUTIONS: CLIMATOLOGICAL AND OTHER APPLICATIONS
Earl E. Lackey Jul. 1967 54 p refs
(TR-68-40-ES; ES-26; AD-667929)

Extended experience in the construction and use of several different predictive nomographs covering a wide range of frequency distributions of various types of weather and other phenomena, suggested the probability that a universal series of patterns of

frequency distributions might permeate the whole of nature. This study is based in part on the several nomographic patterns developed in previous studies. It assumes that all of the frequency distributions we are likely to encounter in practical climatology, whether symmetrical or asymmetrical (skewed), may be fairly well approximated by a family of cumulative frequency curves, provided they are plotted on such a scale that 100 units represents the whole range of observational experience in each. The predictive patterns in the General Nomograph and its associated table depend for their operation on the numerical position of the mean (average) between the two extremes (maximum and minimum) in the frequency distribution, when the three related measures are reduced to a 100-unit scale. The means of frequency distributions having various degrees of skewness lie along a diagonal line from the lower left to the upper right of the basic section of the nomograph. Other lines (curved) trace the values of other percentile or fractional parts of the various distributions. The construction, use and reliability of this nomograph and its associated table are given in this report.
Author (TAB)

N68-26307# Army Materiel Command, Hanover, N. H. Cold Regions Research & Engineering Lab.

SNOW ACCUMULATION STUDIES ON THE THULE PENINSULA, GREENLAND

Steven J. Mock Feb. 1968 29 p refs
(RR-238; AD-667947)

Data from stake measurements, marker boards and pits along a 136-km trail crossing the Thule Peninsula sector of the Greenland ice sheet have been used to determine both the regional and local distribution of snow accumulation. On a regional scale, trend surfaces of mean annual accumulation can be adequately predicted from a model using distance from moisture source and elevation as independent parameters. A series of steplike or wavelike features breaks the smooth profile of the ice sheet and causes profound changes in accumulation rates on a local scale. The accumulation pattern over these features can be predicted from surface slope and departure from regional elevation. Profiles of surface and subsurface topography indicate a direct relationship between subsurface hills and steplike features but cannot be quantitatively accounted for by existing ice flow theory. Detailed accumulation studies in conjunction with a program of spirit leveling in the vicinity of Camp Century have revealed the development of a shallow valleylike feature. Within this feature accumulation rates have increased, indicating that it is the result of flow phenomena.
Author (TAB)

N68-26319# Naval Research Lab., Washington, D. C.

ELECTRON CONTENT FLUCTUATIONS ASSOCIATED WITH A MAGNETIC STORM COMMENCING ON MAY 25, 1967

John M. Goodman, Melvin W. Lehman, and Edward Piernik Mar. 1968 23 p refs
(NRL-MEMO-1858; AD-668213)

VHF transmissions (137.350 MHz) from geostationary satellite ATS-1 (1966 110A) have been analyzed to determine the fluctuations in ionospheric electron content associated with magnetic storm No. 122 which began on May 25 (0735 EST) and ended on May 27 (0100 EST). Coincident with the advent of extremely disturbed propagation conditions in the HF band was an estimated increase in the ionospheric electron content of approximately 100 percent which occurred over a period of 90 minutes. This apparent increase in electron content during the positive phase of this large magnetic storm may be real and if so is in general consistent with the results of others. However, due to ray path obliguity, the possible effects of severe horizontal gradients and electronic redistribution upon the Faraday rotation measurements may distort the results to some extent. Severe amplitude scintillation occurred following the measured content excursion and its index was about 100 percent until midmorning.
Author (TAB)

N68-26333# Columbia Univ., Dobbs Ferry, N. Y. Hudson Labs.

TWO MAGNETIC AND BATHYMETRIC PROFILES ACROSS THE ATLANTIC OCEAN AND THE MID-ATLANTIC RIDGE

J. Brakl Feb. 1968 15 p refs
(Contract Nonr-266(84))
(CU-167-68-ONR-266-Phys.; TR-141; AD-668340)

The bathymetric and geomagnetic results of two North Atlantic crossings between Bermuda and Rota, Spain and Puerto Rico and Dakar are presented and discussed.
Author (TAB)

N68-26339# Army Cold Regions Research and Engineering Lab., Hanover, N. H.

BREAKUP OF ICE, MEADE RIVER, ALASKA

Philip L. Johnson and Frank B. Kistner Oct. 1967 18 p refs
(CRREL-SR-118; AD-667946)

The climatic conditions and chronology of ice breakup on the Meade River, Alaska, in 1966 are reported and documented photographically. These observations and the interpretation of aerial photography suggest that ice damming, flooding, and dam release are the typical patterns of breakup that progress repetitiously downstream. The implications of ice breakup on plant succession on river bars and on channel erosion are discussed.
Author (TAB)

N68-26340# Boston Coll., Chestnut Hill, Mass.

MULTISPECTRAL PHOTOGRAPHIC STUDIES OF A RED-BED FACIES, MINAS BASIN, NOVA SCOTIA

George D. Brown, Jr., John F. Cronin (AFCRL), James W. Skehan, Richard W. Dowling (AFCRL), and Dennis W. O'Leary L. G. Hanscom Field, Mass. AFCRL Nov. 1967 36 p refs *Its* Environ. Res. Papers No. 276
(Contracts AF 19(628)-5737; AF 19(628)-3990)
(AFCRL-67-0603; AD-668438)

For certain geologic-atmospheric interface environments, spectral photometric and photographic techniques are useful in three ways: first, to delineate lithologic units; second, to determine lithologic characteristics; and third, to provide information of the present environment. Investigations were conducted at two sites in the Minas Basin of Nova Scotia where variegated beds of the Triassic Wolfville and Blomidon formations are exposed. Laboratory spectrophotometric measurements, field photometric data, and narrow band photography of the sedimentary units demonstrate an increase, in the visible spectrum, of reflectivity with increase in wavelength of the incident radiant energy. Inorganic encrustations substantially alter the spectral characteristics of sedimentary units in situ.
Author (TAB)

N68-26341# Radiation Research Associates, Inc., Fort Worth, Tex.

ATMOSPHERIC PATH RADIANCE CALCULATIONS FOR A MODEL ATMOSPHERE

Dave G. Collins 13 Mar. 1968 30 p refs
(Contract F19628-67-C-0298)
(RRA-M-82; SR-1; AFCRL-68-0124; AD-668482)

The LITE-II Monte Carlo Program was used to calculate background radiances and path radiances as a function of altitude and direction for a model atmosphere illuminated by a broad beam monodirectional-monochromatic light source located at the top of the atmosphere. The model atmosphere has a ground level visibility of 25 km. LITE-II calculations were run for seven monochromatic plane light sources with wavelengths between 0.35 and 0.95 microns and angles of incidence between 0 and 85 degrees. Path radiances were calculated as a function of altitude and direction for each wavelength and incident angle for Lambert type ground reflection surfaces having albedoes that vary from 0 to 0.9. Intensities as a function of altitude and direction that result from

light scattered by the ground were calculated for surfaces having Lambert type reflection properties. Data will be presented that show the relative importance of the path radiance and ground reflectance, as a function of both direction and altitude for the various source wavelengths and source zenith angles considered. Author (TAB)

N68-26410# Lincoln Lab., Mass. Inst. of Tech., Lexington.
MILLSTONE HILL THOMSON SCATTER RESULTS FOR 1964
John V. Evans 15 Nov. 1967 53 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-563; TR-430; AD-668436)

Thomson scatter (incoherent backscatter) observations of the ionosphere were made at Millstone Hill at a wavelength of 68 cm during 1964, for 30-hour periods every two weeks. These data have been employed to derive the mean hourly F-region (200 to 700 km) electron density profile and electron and ion temperature curves in each month. The results are presented in this report, together with the derived seasonal variation of electron density (at 0600, 1200, 1800 and 2400 hours local time) and the average daytime (0900 to 1500) and nighttime (2100 to 0300) electron and ion temperature behavior. Separate measurements with a 23-cm radar permitted the temperature results reported to be extended to lower altitudes (130 km) and, in addition, provided information concerning the ionic constituents between 130 and 230 km. Author (TAB)

N68-26418# Lockheed Missiles and Space Co., Palo Alto, Calif.
AURORAL INPUT–OUTPUT EXPERIMENT Final Report, 1 Apr. 1961–31 Jan. 1968
John E. Evans, Richard G. Johnson, and Roland E. Meyerott 31 Jan. 1968 310 p refs
(Contract Nonr-3398(00))
(LMSC-8-79-68-1; AD-668202)

A study of the use of natural phenomena to simulate radio and radar blackout effects led to the development of the auroral input-output experiment. The objective was to fully document several pertinent parameters in a volume of the upper atmosphere being bombarded by fast particles. Incoming energetic particles (the input) producing the auroras were measured by an instrumented polar orbiting satellite. The optical emissions and integrated electron content (the outputs) were measured simultaneously and with good geometry by photometers and radio receiving equipment (for receiving signals from the satellite borne radio beacon) on instrumented aircraft and/or ground stations. Low energy (20 eV to 100 keV) electron and proton detectors, photometers, beacons and fast data handling equipment were developed for seven satellite packages, four of which have provided extensive data on particle fluxes, angular distributions, energy spectra and precipitation patterns and on 3914 A and vacuum uv emissions. A 5-channel filter scanning photometer (1 scan/sec) and a 3-frequency (20, 40 and 120 MHz) phase locked coherent receiver for signal strength and differential Doppler electron content measurements plus auxiliary optical and tape recording gear were adapted to aircraft use and were operated underneath the satellite transits over the auroral zone in Alaska. Author (TAB)

N68-26489# Chicago Univ., Ill. Dept. of the Geophysical Sciences.
LONG WAVES OVER WAVY BOTTOMS
L. F. McGoldrick Jan. 1968 69 p refs
(Contract N00014-67-A-0285-0002)
(TR-1; AD-668185)

The propagation of long waves over bottoms having sinusoidal undulations is investigated here within the confines of linearized shallow water theory. It is found that the presence of this irregularity in most cases impedes the propagation of the wave in keeping with the proper application of the Green-DuBoys formula. For wavelengths for which this formula is not valid, or those of the same order as the bottom wavelengths, it is found that there is a region for which the propagation is not retarded, and the travel time is less than that based upon the mean depth. Furthermore, the presence of regular undulations of the bottom of any amplitude prohibits the propagation of an infinite sequence of wavelengths on the surface, the most significant of which are those of the same order as the bottom. These waves are unstable, and through resonance with the bottom will grow without bound as they progress, or at least until the linearized theory is invalidated. An electrical analog is presented which exhibits the same instability, a subharmonic resonance, and can be used to determine the free surface profiles. Author (TAB)

N68-26493# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
ACOUSTICAL, METEOROLOGICAL, AND SEISMIC DATA REPORT—SOTRAN 5 AND 6
Ralph H. Rohwer Oct. 1967 98 p refs
(ECOM-5162; AD-667915)

The report, the third of the SOTRAN series, is a compilation of data acquired from the detonation of two 50-ton stacks of TNT at White Sands Missile Range on 15 and 24 June 1967. Meteorological, acoustical, and seismic data are presented along with other general information about the events. Octave filter runs have been made from available tapes to show the general character of the acoustics data, but no attempt has been made to derive results. The report serves as a summary of the data available for those who wish to make further studies of the two explosions. Author (TAB)

N68-26597# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE APPLICATION OF NUCLEAR MAGNETIC RESONANCE (YAMR) FOR DIFFERENTIAL MEASUREMENTS IN THE MAGNETIC FIELD OF THE EARTH [O PRIMENENII YAMR DLYA DIFFERENTSIAL'NYKH IZMERENIY V MAGNITNOM POLE ZEMLI]
A. V. Mel'nikov 21 Jul. 1967 27 p refs Transl. into ENGLISH from Univ. Yadernyy Magnitn. Rezonans (Leningrad), no. 1, 1965 p 49–63
(FTD-MT-24-100-67; AD-668160)

The author discusses the principles for constructing systems to use the nuclear magnetic resonance method for differential measurements in the magnetic field of the earth and some of the physical problems involved in putting these systems into operation. The literature on differential magnetometers is reviewed and the problems of reducing inherent noises and shielding from external interference are considered. An approximate comparative evaluation is made of the freedom from interference in various differential magnetometers with the following simplifying assumptions: (1) the spectral density of the input noises for the equipment in the working frequency range is constant, (2) the noise factor for all systems is identical and is determined by the devices preceding the indicator. Some additional sources of error are discussed. TAB

N68-26635# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
ROCKET MEASUREMENTS OF ATMOSPHERIC OZONE
Jagir S. Randhawa Jan. 1968 31 p refs
(ECOM-5169; AD-667919)

The rocket-borne ozonesonde, which has been developed by the Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico, and utilizes the chemiluminescent principle for ozone detection, has been flown at Fort Greely, Alaska (64N) and

White Sands Missile Range, New Mexico (32N) during different times in 1967. The data gathered from these soundings are presented. The ozone concentration found in the lower stratosphere agrees with data from balloon soundings, while in the upper stratosphere it is found to be five times greater than measured by spectrometric methods. Author (TAB)

N68-26639# Sandia Corp., Albuquerque, N. Mex.
INVESTIGATION OF TMAE AS A CHEMILUMINESCENT ATMOSPHERIC TRACER
R. M. Elrick and R. E. Smith May 1967 57 p ref
(Contract AT(29-1)-789)
(SC-RR-66-2693) CFSTI: HC $3.00/MF $0.65

TMAE is a chemiluminescent liquid which is attractive for use as a tracer in studying the fall and dispersion of particles released in the atmosphere. TMAE field tests were conducted at the Tonopah Test Range and results suggest quantitative limits on the use of photographic and TV coverage for tracking clouds of particles in the atmosphere. NSA

N68-26779# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN PECULIARITIES OF MAGNETIC IONOSPHERIC DISTURBANCES IN THE TRANSITION ZONE [NEKOTORYYE OSOBENNOSTI MAGNITNO-IONOSFERNYKH VOZMUSHCHENIY V PEREKHODNOY ZONE]
Ye. P. Glushkova 1 Sep. 1967 25 p refs Transl. into ENGLISH from an SSSR. Mezhduved. Geofiz. Kom. V Razdel Programmy Mgg (Ionosfera). Sb. Statey (USSR), no. 14, 1965 p 104–116
(FTD-MT-24-160-67; AD-668064)

The author discusses in detail peculiarities of magnetoionospheric disturbances in the transition zone; the upper limits in the Eastern Hemisphere are near 62 N and in the Western Hemisphere near 42 N, and the lower limits in the Eastern and Western Hemispheres are 55 N and 35 N, respectively and are located near the auroral zone. Observations covered the period extending mainly over the last months of 1958 and most of 1959 because the most complete data on ionospheric observations made with vertical soundings made available to the author covered this period. The article shows that during severe, very strong magnetic storms, Ds-variations of H and Z components of the geomagnetic field occur in synphases. Phenomena characteristic of the auroral-zone disturbances are observed in the ionosphere. Blackouts are observed only in cases during the positive phase of a storm when a sudden peak in the H component, warns of the approach of the current system to the observation point. Moreover, the negative phase of the storm should be well developed. As the transition zone is located approximately in the latitudes where the outer radiation belt is closest to the earths surface, it is suggested that there may be connection between certain phenomena observed during magnetoionospheric disturbances and the movement of particles in the outer radiation belt. Author (TAB)

N68-26807*# Eastern Airlines, Inc., Miami, Fla.
ATMOSPHERIC TEMPERATURE GRADIENTS RELATED TO CLEAR AIR TURBULENCE IN THE UPPER TROPOSPHERE AND LOWER STRATOSPHERE
Paul W. Kadlec Nov. 1967 16 p refs
(Contract NAS4-1194)
(NASA-CR-91055) CFSTI: HC $3.00/MF $0.65 CSCL 04A

An investigation was made to determine whether any specific patterns in the vertical temperature profile were found to be associated with horizontal temperature gradients and/or significant clear air turbulence. From the analysis of the temperature lapse rate at subsonic cruising altitudes, it was observed that 77% of the significant turbulence at reduced airspeed occurred below the tropopause. Furthermore, the temperature at the base of the tropopause inversion was colder than standard in 70% of the cases. The presence of the jet stream was found to be the most common feature of the upper air pattern associated with significant turbulence. Temperature profiles above 100 millibars (53,000 feet) indicated a relationship between temperature increases in stratospheric inversions at a rate of 1.5°C or greater per 1000 feet and significant turbulence below 41,000 feet. Also, a gradual temperature increase with altitude of approximately 1.0°C or more per 1000 feet above the highest inversion (above 100 millibars) was found to have a similar correlation to significant turbulence at lower altitudes. Data from five XB-70 test flights were analyzed in conjunction with information compiled on coincidental commercial jet flights to further explore the temperature/turbulence relationship. Moderate turbulence was encountered on only one flight of this series. Author

N68-26808# Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
TWO-DIMENSIONAL ANALYSIS OF STRESS AND STRAIN IN SOILS: PLANE-STRAIN LOADING OF A STRAIN HARDENING SOIL Final Report
Wilson H. Tang and Kaare Hoeeg Mar. 1968 81 p refs *Its* Soil Publ. No. 207
(Contract DA-22-079-ENG-471)
(R68-4; Rept.-3-129; Rept.-5; AD-668240)

The research is aimed at providing fundamental information on the degree to which modern numerical techniques and the theory of plasticity can be used to simulate actual soil response. It is hoped that the results, examined in the light of experimental data, can be used as a guide in assessing the validity of the application of these methods to more complicated soil-structure interaction and free field response computations being used in the analysis of the effects of nuclear weapons on underground protective structures. Based on recent developments by Roscoe et al (1958) and others. Idealized stress-strain relations for a strain-hardening soil were formulated and discussed. The main objective of this report was to apply the suggested formulation to the simple physical situation of a strip footing in order to evaluate the assumptions used for the strain-hardening behavior. To perform the numerical computations, the soil continuum was replaced by a lumped parameter model, and the resulting algebraic equations were solved by a digital computer. Earlier work at Massachusetts Institute of Technology had developed a computer program for static plane strain analysis, and this report formulated a corresponding analysis for dynamic response. Then the study proceeded to use both these programs to determine the load-settlement curve for a strip footing. The last part of the report evaluates the proposed strain-hardening behavior and includes recommendations for modifications and future work. It is believed that the approach outlined represents a very useful method to improve current understanding of basic soil behavior. Author (TAB)

N68-26810# Milan Univ., (Italy).
THE ATMOSPHERIC AND LEAKAGE FLUX OF NEUTRONS PRODUCED IN THE ATMOSPHERE BY COSMIC RAY INTERACTIONS
G. Boella, C. Dilworth, M. Panetti, and L. Scarsi 15 Dec. 1967 38 p refs
(Contract AF 61(052)-808)
(SR-5; AFCRL-68-0173; AD-668483)

The curve of the integrated neutron flux in the 'thermal' to 20 MeV energy range, as a function of the atmospheric depth from sea level up to 0.1 mbar, has been obtained, assuming as energy spectrum that predicted by Newkirk. The instrument employed is a combination of an hydrogeneous moderator with a slow neutron detector, with anticoincidence rejection of background events. Four

balloon flights have been carried out in March 1966: one rocket flight in July 1966. With this flight the curve has been extended to 0.1 mbar from 6 mbar, attained with the balloon flights. The neutron flux as a function of the atmospheric depth is given, at 5.3 GV geomagnetic cut-off rigidity, in quiet sun conditions.
Author (TAB)

N68-26841# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
GUN LAUNCHED PROBES—PARACHUTE EXPULSION TESTS UNDER SIMULATED ENVIRONMENT
L. Edwin Williamson Feb. 1968 31 p refs
(ECOM-5179; AD-667908)

Experience gained during the early phases of Project Gun Probe at WSMR revealed evidence that the parachute packaging and/or expulsion techniques used at that time were unsatisfactory. Tests were planned to evaluate the technique visually, utilizing high-speed cameras and simulated environments. The 60-foot vacuum sphere at the NASA facility at Langley Research Center was made available, and six tests were successfully conducted. Results of the tests indicated that only minor modifications to the existing technique were necessary to produce a completely acceptable system.
Author (TAB)

N68-26932# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
ON THE KERATOPHYRE-SPILITIC FORMATION OF THE SOUTH YENISEY MOUNTAIN RIDGE AND THE POSSIBLE NATURE OF THE KASSKAYA MAGNETIC ANOMALY [O KERATOFIRO-SPLITOVOY FORMATSII YUZHNO-YENISEY-SKOGO KRYAZHA I VOZMOZHNOY PRIRODE KASSKOY MAGNITNOY ANOMALII]
E. B. Nalivkina Feb. 1968 11 p refs Transl. into ENGLISH from Geol. i Geofiz. (Novosibirsk), no. 1, 1965 p 169–172
(ACID-TC-1351; AD-668176)

The translation is of a work which drew the following conclusions: (1) The Yenisey metamorphic complex, or at any rate a considerable part of it, represents a metamorphized keratophyre-spilitic formation. (2) Ferrour quartzites are spatially and genetically connected with similar Pre-Cambrian formations of the world. (3) Rocks of the keratophyre-spilitic formation of Southern Yenisey ridge subside in a northwestern direction. These formations and higher horizons of the above-indicated formation obviously compose the Pre-Cambrian basement of the West-Siberian lowland in the region of the Kasskaya magnetic anomaly. (4) All that has been mentioned above indicates the possible occurrence of ferrons quartzites in the Pre-Cambrian foundation of the West-Siberian lowland in the region of the eastern part of the Kasskaya magnetic anomaly. (5) It is possible to assume that in Central Siberia there is located a basin of iron ore similar to that of the Kursk-Kriway Rag Basin.
Author (TAB)

N68-26933# Air Force Cambridge Research Labs., Bedford, Mass. Space Physics Lab.
ELECTRIC FIELD IN THE IONOSPHERE: A THEORY OF ITS ORIGIN AND EFFECT
Hari K. Sen Mar. 1968 20 p refs Presented at the 4th Intern. Conf. on the Universal Aspects of Atmospheric Elec., Tokyo, 12–18 May 1968 /ts Environ. Res. Papers No. 282
(AFCRL-68-0134; AD-668092)

The anomalously high electron temperature in the lower ionosphere (E-region) cannot be attributed to photoelectrons (Spencer and Brace, 1965). In this report, it is shown that electric fields due to charge separation in the dynamo region provide adequate energy for this purpose. Application of the formula for the velocity distribution of the electrons in crossed electric and magnetic fields (Sen and Wyller, 1960) to the observational data gives electric fields perpendicular to the magnetic field of intensity about 20 to 40 V/km. This is an order of magnitude higher than that obtained in the current dynamo theory. A theory of the origin of the electric field in charge separation due to neutral wind drag is given. The theory leads to the right order of magnitude estimate of the dimensions of ionospheric irregularities. Another likely source for the electric field is where the solar wind meets the magnetosphere (magnetopause). It is shown that a field approx. 1 V/m can build up in the magnetospheric plasma sheath, as in a discharge tube, and be conducted down into the ionosphere along the lines of magnetic force. It is further shown that an electric field of this magnitude can cause the requisite auroral particle acceleration and sheath current for the main phase of magnetic storms.
Author (TAB)

N68-26934# Texas Instruments, Inc., Dallas. Science Services Div.
UNITED STATES NAVAL OCEANOGRAPHIC OFFICE MARINE GEOPHYSICAL SURVEY PROGRAM 1965–1967 NORTH ATLANTIC OCEAN, NORWEGIAN SEA, AND MEDITERRANEAN SEA AREA 2. VOLUME 6: OCEANOGRAPHIC STATIONS AND VELOCITY PROFILES Final Report
19 Feb. 1968 211 p refs
(Contract N62306-1687)
(SP-95-2-6; AD-668178)

The report presents oceanographic data in Volume 6 Area 2. In addition to velocity profiles, the volume presents core physical properties, temperature-salinity plots and bottom photographs. Sound velocities computed from hydrographic data are compared to directly measured values.
Author (TAB)

N68-26939# Instituto Geografico y Catastral, Madrid (Spain).
INTRODUCTION TO THE GRAVITATIONAL MEASUREMENT STUDY OF FERNANDO POO [INTRODUCCION AL ESTUDIO GRAVIMETRICO DE FERNANDO POO]
Angel Garcia Cogollor 1967 88 p refs In SPANISH
CFSTI: HC $3.00/MF $0.65

Topographical description of the island of Fernando Poo and distribution of gravimetric observation stations comprising the Geodetic network are presented. The observations for the survey epoch July to November 1964 are tabulated. Details of making observations and equipment utilized, reduction of observed data, and explanation of anomalies are shown.
Transl by F.S.

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N68-25657# Rochester Univ., N. Y. Atomic Energy Project.
DETECTOR FOR USE AROUND THE UNIVERSITY OF ROCHESTER'S 20 MEV EMPEROR TANDEM VAN DE GRAAFF ACCELERATOR
Bernard R. Gifford, Herbert Mermagen, and H. David Maillie 9 Feb. 1968 25 p refs
(Contract W-7401-ENG-49)
(UR-49-903) CFSTI: HC $3.00/MF $0.65

The accuracy of the Bonner Sphere Neutron Detector in measuring the dose equivalent (DE) for neutron reactions produced by the University of Rochester's 20 MeV Emperor Tandem Van de Graaff Accelerator is evaluated by experimental and theoretical means. Results show that the Bonner Sphere is rem responding

within ±30% for a number of neutron distributions produced by (p,n) (d,n), and (heavy ion,n) reactions with maximum energies up to 25 MeV. A method of analysis is used which could be used to evaluate other neutron detectors, both rem- and non-rem responding. Author (NSA)

N68-25677*# Massachusetts Inst. of Tech., Cambridge.
REFLECTION COEFFICIENTS OF PLANETARY SURFACES FROM UNMANNED SPACECRAFT
J. F. Reintjes [1967] 6 p refs Presented at the Intern. Meeting, 4 Sep. 1967
(Grant NsG-234-61)
(NASA-CR-87661) CFSTI: HC$3.00/MF$0.65 CSCL 17I

A radar-type instrument for measuring the reflection coefficients of planetary surfaces from an unmanned spacecraft is described. The characteristics of the signals involved in the measurement are discussed, and signal characteristics are related to key parameters of the instrument. Special features of the instrument are presented and requirements for stability and control of the spacecraft during measurements are indicated. Calibration data are given for the instrument and a weight budget is listed. Author

N68-25682# Argonne National Lab., Ill.
SUMMARY REVIEW OF FLOWMETERS SUITABLE FOR MEASURING SODIUM FLOW AT TEMPERATURES UP TO 1200 DEG F IN THE FAST-FLUX-TEST-FACILITY (FFTF)
G. F. Popper, D. E. Wiegand, and M. C. Glass Dec. 1967 32 p refs
(Contract W-31-109-ENG-38)
(ANL-7340) CFSTI: HC$3.00/MF$0.65

A comprehensive evaluation of prototype fuel assemblies for sodium-cooled fast-breeder reactors depends, in part, on the development of flowmeters capable of reliable operation under conditions anticipated in the FFTF core. Presented are a review and an evaluation of published information on various flow-monitoring devices and concepts with potential for application in the FFTF. NSA

N68-25691# California Univ., Livermore. Lawrence Radiation Lab.
STUDIES OF A FLUIDIC OSCILLATOR AS A TEMPERATURE SENSOR
R. L. Osborne and D. D. Cooksey 1 Nov. 1967 27 p refs
(Contract W-7405-ENG-48)
(UCRL-50344) CFSTI: HC$3.00/MF$0.65

A fluidic bistable amplifier operating as a control-to-control-port oscillator has been investigated as a temperature sensor. This device offers the advantages of apparently being insensitive to radiation and of being capable of operation at high temperatures limited only by the structural integrity of the fabrication material. Since it operates as a frequency-modulating device, noise problems in data transmission are minimized. The control-to-control-port configuration was used in order to minimize the heat removed from the material whose temperature was being measured. The effects of several process parameters on unit operation were investigated. These included supply pressure to the unit, diameter of the sensing tube and the effects of irregularities in the diameter of the sensing tube. The work showed that a fluidic bistable oscillator can be used as a temperature sensor, operating in the control-to-control-port configuration, provided sufficient attention is paid to the operating parameters and the geometry of the unit. Author (NSA)

N68-25697# Commissariat a l'Energie Atomique, Saclay (France). Centre D'Etudes Nucleaires.
INTRODUCTION TO THE STUDY OF BOILING IN SWIMMING POOL REACTORS. MEASUREMENT OF THE EFFICIENCY OF A C C 5 CHAMBER [INTRODUCTION A L'ETUDE DE L'EBULLITION DANS LES REACTEURS PISCINES. ESSAI DE MESURE DE L'EFFICACITE D'UNE CHAMBRE C C 5]
Bernard Froelicher Nov. 1967 11 p In FRENCH
(CEA-R-3326)

The efficiency of a CC5 ionization chamber has been evaluated by a rough measurement: by integrating the relationship P(f) = εFo(1 + εA) over the band width of the apparatus, it is possible to show the influence of ε. This conventional method of operation is not very precise and so a more realistic value of the efficiency will be derived later using the plot of the low power transfer function of the reactor ULYSSE. NSA

N68-25799# European Atomic Energy Community, Ispra (Italy).
DIGITALIZED TRANSFER FUNCTION ANALYZER FOR PRECISION MEASUREMENTS
I. Bredael, A. Garroni, and F. Sciuto Brussels Apr. 1968 24 p
(EUR-3916.e) CFSTI: $3.00

The equipment described enables to carry out transfer function measurements in the 0.005 to 50 Hz range. The overall precision reached in the 2 × 4 digit numerical indications of the results is obtained by a digital conversion of the input signal and a completely numerical processing of the signal. The reference signals may be generated internally, or by an 8192 bit diode matrix and delivered for perturbation use in the digital form by means of a stepping motor, the velocity of which is then sinusoidally modulated or by a digital-to-analog converter which delivers a normal sinusoidal variation signal. This signal can (after amplification) be used to drive a normal D.C. or A.C. motor. The reference signals may also be generated externally by an original photoelectric encoder delivering the sine and cosine time modulated pulses. In this case the shaft encoder would be mounted on the mechanical apparatus under testing. This equipment is particularly useful in vibration analysis. Author

N68-25810# Central Mechanical Engineering Research Inst. Durgapur (India).
A DIGITAL COUNTER
T. Singh, N. P. Daw, and R. Mariadoss Dec. 1967 16 p refs
(A15) CFSTI: HC$3.00/MF$0.65

The report describes the principle of operation and design aspect of the digital counter developed at CMERI. The maximum speed of the counter is 500 kc/s with an accuracy of ±1 cycle plus the stability of the crystal oscillator. A higher counting speed may be attained by incorporating a high frequency decade. An array of neon indicators is employed to display the counts. Author

N68-25830*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE INFLUENCE OF FIXTURE STRESS CONCENTRATIONS ON RING ACCELEROMETERS
James A. Nagy and Charles E. Henley, Jr. Washington May 1968 11 p refs
(NASA-TN-D-4540) CFSTI: HC$3.00/MF$0.65 CSCL 14B

Tests have revealed that the most commonly used accelerometer can be subject to a subtle source of error from strains developed in vibration fixtures. Accelerometers mounted on supposedly rigid surfaces may show errors on the order of 100 percent at the very low frequencies below any resonances. A study was initiated to determine the nature of the fixture stress concentration and means of avoiding it. This paper describes the test methods used during the study and the results obtained. The test methods discussed include standard accelerometer calibration techniques; calibrations varying torque, position, and mounting hole angle; photoelastic techniques; base sensitivity checks; and tests with a transducer devised to detect the presence of base-strain in mounted accelerometers. Author

N68-25862*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE INTERPRETATION OF DAYTIME MEASUREMENTS BY THE NIMBUS 1 AND 2 HIGH RESOLUTION INFRARED RADIOMETERS

G. Kuers Washington Jun. 1968 23 p refs

(NASA-TN-D-4452) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Dense cumulus clouds and fog banks have been selected to determine mean values of their reflectances by means of the High Resolution Infrared Radiometers (HRIR) of Nimbus I and Nimbus II in the wavelength region between 3.6μ and 4.2μ. While both instruments yielded satisfactory results at night, it became apparent that Nimbus I delivered too high reflectance values by day. It was concluded that spurious shortwave radiation entered the radiometer. The amount of the energy difference was used to determine the most probable cause of the malfunctioning, which was considered to be an uncoated rim or a crack of the interference filter. Author

N68-25878*# Geological Survey, Washington, D. C.

GENERATION OF HOUSING QUALITY DATA FROM MULTIBAND AERIAL PHOTOGRAPHS

Barry S. Wellar (Northwestern Univ.) May 1968 114 p refs

(NASA Order R-09-020-015)

(NASA-CR-94929; NASA-119) CFSTI: HC $3.00/MF $0.65 CSCL 08F

This study attempts to discover significant correlates of poor housing quality using data obtained from multiband aerial photographs. A procedure is developed which is claimed to be a rapid, reliable and objective source of housing data, with an inherent flexibility for changing the boundaries of the study area. The conclusions drawn from the analysis are represented in appraisal forms containing structural and environmental indicators of housing quality which can be generated from the multiband aerial photographs. The most consistent indicators of low quality housing are found to be: (1) the presence of litter, garbage, wrecked or derelict cars, and piles of lumber and other rubbish on occupied as well as vacant lots; (2) lack of landscaping in yards and parkways and presence of weeds on vacant lots; (3) the number of vacant lots; (4) non-residential hazards and nuisances, including industrial plants and warehouses; and (5) the degree of lot-crowding, that is, lack of "free space" per lot. These criteria have not yet been established by statistical analysis, but, on the basis of frequency of appearance and level of association, there are plausible grounds for selection of these criteria that are consistently present in low quality housing areas. Author

N68-26903*# Northrop Corp., Hawthorne, Calif.

A STUDY OF AN ELECTRIC FIELD MEASURING INSTRUMENT

S. H. Levine and S. R. Harrison Washington NASA Jun. 1968 44 p refs

(Contract NAS2-4143)

(NASA-CR-970; NCL-67-39) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The feasibility of employing a cesium ion beam electric field meter has been experimentally investigated in the laboratory using two types of cesium ion sources. The first source used radiant heating, the other electron bombardment heating. Excellent results were obtained with these sources attaining a sensitivity for measuring electric fields of 0.03 volts/meter. Methods for attaining sensitivites of the order of 0.01 V/m are presented together with a preliminary theoretical investigation of the processes pertaining to the production of cesium ions in the ionizer. Also, an electronic-readout system design is presented so that all aspects of constructing a cesium ion beam electric field instrument have been studied. Author

N68-25941 Brown Univ., Providence, R. I.

AN ABSOLUTE DETERMINATION OF THE VISCOSITY OF SEVEN GASES TO HIGH TEMPERATURES

Ronald di Pippo (Ph.D. Thesis) 1966 111 p

Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-2231

This thesis describes the design and operation of a new, oscillating-disk viscometer. Measurements are reported of the dynamic viscosity of seven gases, including air, argon, carbon dioxide, helium, krypton, neon and nitrogen, at temperatures ranging from room temperature to 500°C, at pressures near atmospheric. The results are evaluated on an absolute basis with the aid of G. F. Newell's theory. Statistical-mechanical correlations are performed for several molecular models, and force parameters are fitted to the data. The various models are examined with the aid of calculations of the second virial coefficient, and thermal conductivities are evaluated from the present viscosity values for the monatomic gases under consideration. The molecular models used in the study are the Lennard-Jones (6-12) potential, the modified Buckingham (exp-6) potential and the Kihara spherical-core potential. Dissert. Abstr.

N68-25957 Technisch Physische Dienst TNO-TH, Delft (Netherlands).

DETERMINATION OF RESOLUTION OF FOUR TA-7M CAMERA OBJECTIVES [HET BEPALEN VAN HET SCHEIDEND VERMOGEN VAN 4 OBJECTIEVEN VAN DE TA-7M CAMERA]

A. van Milaan and J. Veldman 15 Feb. 1968 14 p In DUTCH

(TDCK-50175; Rept.-68-0-1) CFSTI: $3.00

Measuring arrangements and results are presented of resolution tests with four objectives of f' = 100 mm 1:1.4, f' = 64 mm 1:1.8, f' = 70 mm 1:1.6, and f' = 52 mm 1:2.7. The objectives are designed for use in the TA-7M daylight aerial reconnaissance photographic system. Transl. by K.W.

N68-26060# Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.

SMALL SHIELDED THERMOCOUPLE TOTAL TEMPERATURE PROBES Interim Scientific Report

Josef Rom and Yigal Kronzon Dec. 1967 20 p refs

(Contract F61052-67-C-0033)

(TAE-79; SR-6; AD-668466)

The design and the calibration of 2 mm and 3 mm O.D. shielded thermocouple total temperature probes are described. The 3 mm O.D. probe recovery factor is 0.985 plus or minus 0.005 and the 2 mm O.D. one is 0.975 plus or minus 0.005 up to flow Mach number of 3.5. The probe response is only slightly dependent of Reynolds number. By positioning of the thermocouple junction at the vent holes position its output becomes sensitive to disturbances, such as shock waves in the flow. This characteristic of the probe can be useful in mapping of discontinuities in complicated flow fields. Author (TAB)

N68-26103# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

IMAGE QUALITY EVALUATION BY OPTICAL ANALOG TRANSFORM TECHNIQUES Final Report, Jul.-Nov. 1967

George H. Snider Griffiss AFB, N. Y. RADC Mar. 1968 47 p refs

(Contract F30602-67-C-0349)

(CAL-VE-2491-0-1; RADC-TR-67-666; AD-668123)

This report presents the results of a novel method for quantitatively assessing the quality characteristics of reconnaissance photographs by optical analog transform techniques. The method is desirable because it is simple, objective, and amenable to automation. It involves placing reconnaissance photographs in the object plane of a spatial filtering apparatus and measuring the

power levels in two spatial frequency regions. One region is in the middle frequencies where contrast and transfer function affect the power. The other region is in the high frequencies where granularity affects the power. The quotient of these powers (mid/high) is the quality measure. It is concluded that the method is useful when scene complexity is adequate and constant. Recommendations are made for improvements to the system to extend its usefulness to less complex scenes and possibly compare photographs of scenes of different complexity. Author (TAB)

N68-26171 Technisch Physische Dienst TNO-TH, Delft (Netherlands).
COMPARATIVE RESEARCH ON VIBRATION TRANSDUCERS IN USE AT THE TECHNICAL PHYSICS SERVICE TNO-TH [VERGELIJKEND ONDERZOEK AAN TRILLINGOPNEMERS IN GEBRUIK BIJ DE TECHNISCH PHYSICHE DIENST TNO-TH]
F. H. Van Tol 19 Jan. 1968 34 p In DUTCH; ENGLISH summary
(TDCK-50121; Rept.-508.125) CFSTI: $3.00

It has been observed that some piezoelectric accelerometers used in vibration measurements may give erroneous results when mounted on thin plate structures. Tests were therefore conducted to verify the reliability of the accelerometers in use at this laboratory. Results and conclusions obtained in testing 16 accelerometers are given. In general, models of fairly recent design were found to be reliable for all measurements, while some older designs were reliable only on heavy structures. K.W.

N68-26175*# Auburn Univ., Ala. Advanced Studies Group.
AN ANALYSIS OF A SINGLE AXIS PLATFORM
J. L. Lowry Dec. 1966 65 p refs
(Contract NAS8-20004)
(NASA-CR-61833) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The principles of operation of the gyroscope and the ideal Single Axis Platform (SAP) are reviewed. The equations of motion of an ideal SAP are derived and a signal flow graph and a block diagram are constructed from the equations of motion. The equations of motion of an ideal SAP,when the torsional stiffness of the gas bearing between the float and gimbal is considered, are presented, and a signal flow graph and a block diagram are constructed from these equations of motion. A discussion of the stability of the ideal SAP with finite and infinite torsional stiffness of the gas bearing is presented. The analysis of an ideal SAP for various inputs is also given. Author

N68-26241# Washington Univ., Seattle. Dept. of Civil Engineering.
EVALUATION OF POINTING TO A SHARP EDGE
Kenneth Lund and J. E. Colcord Apr. 1968 72 p refs
(Contract DA-44-009-AMC-1492(x))
(AD-668260)

The report includes the design of an apparatus to measure the ability of observers to point on a sharp black white edge at a standard test distance of 6 meters to a least count of better than 0.1 second of arc. The parameters measured were the size of circular measuring marks, illumination, and occular openings. The results show the effect of these variables on the task, the optimum design parameters, and point out the wide variability in absolute observer performance in both tangent and center settings. The general results suggest a standard deviation of about 10 seconds of arc on the average at optimum conditions. Author (TAB)

N68-26244*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TECHNIQUES OF SPACE PHOTOGRAPHY
Robert L. Summers Washington 1967 36 p Presented at Natl. Electron. Conf., 1967 Student Program, Chicago, 24 Oct. 1967
(NASA-TM-X-52341) CFSTI: HC $3.00/MF $0.65 CSCL 14E

In order to demonstrate the role and importance of photography in space exploration, the equipment used to provide photographic information on the surface topography of the Moon and Mars is discussed. The design requirements and constraints are given for camera systems flown on the Ranger, Surveyor, Lunar Orbiter, and Mariner 4 spacecraft. The operating characteristics of the various camera systems are presented along with some of the main purposes and accomplishments of each. As the launch and flight profiles of the four missions are similar, the launch of the Ranger spacecraft was recounted as a typical example. B.S.D.

N68-26386# Harry Diamond Labs., Washington, D. C.
FLUIDIC STALL SENSING SYSTEM
Raymond W. Warren and Elmer L. Swartz Feb. 1968 40 p
(HDL-TR-1368; AD-667936)

The fluid stall sensor is a remote indicating system for detecting stall on aircraft wings. When the flow is attached to the wing, it causes aspiration from a probe just above the wing surface. Separated flow, associated with stall, decreases the aspiration. The change in aspiration is amplified by a high impedance fluid amplifier which drives an indicator. The position of indicators from several probes across the wing gives an indication of the amount of lift remaining. Author (TAB)

N68-26437# Oak Ridge National Lab., Tenn. Health Physics Div.
NEUTRON-ENERGY THRESHOLD DETECTOR SYSTEM EMPLOYING SOLID-STATE NUCLEAR TRACK DETECTOR AND FISSILE RADIATOR UNITS
G. D. Kerr Mar. 1968 21 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2120) CFSTI: HC $3.00/MF $0.65

Improvements have been made in threshold detector systems used for measurement of neutron fluence and dose by the application of solid-state nuclear track detector–fissile radiator units. Fission fragment tracks in the detectors are exposed by chemical etch and viewed with an optical microscope. Detection efficiencies for these units, techniques for evaluation of Lexan nuclear track detectors, and data used in fluence and dose calculations are given. Absorbed doses in a small sample of tissue from a fast fission spectrum of neutrons can be measured over a range of 1 to 10^4 rads with ^{238}Pu, ^{237}Np, and ^{238}U fissile radiators of 30, 50, and 30 $\mu g/cm^2$ respectively. Comparisons with conventional threshold detector systems under a variety of exposure conditions have given agreement to within 10%. Author (NSA)

N68-26440# Central Electricity Generating Board, Berkeley (England). Research and Development Dept.
A PHILIPS EM200 ELECTRON MICROSCOPE HOLDER FOR FIELD ION MICROSCOPE SPECIMENS
J. T. Buswell and G. K. Rickards Feb. 1968 6 p ref
(RD/B/M-1032)

A holder was constructed for examining field ion microscope specimens by transmission electron microscopy in a Philips EM200 Electron Microscope. The design of the holder also enables the field ion tips to be irradiated in an ion accelerator in directions parallel to, or perpendicular to, the tip axis. Author (NSA)

N68-26452# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
FABRICATION OF AN IMPROVED FROST-POINT HYGROMETER SENSING ELEMENT

J. J. Prislinger and S. H. Jury (Tenn. Univ., Knoxville) Apr. 1968 11 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2123) CFSTI: HC $3.00/MF $0.65

A new frost-point hygrometer sensing element is described wherein design for superior performance generates metal joining problems involving gold, silver, Monel, stainless steel, and Invar. The solutions to these problems and the method of fabrication are described in detail. Author (NSA)

N68-26456# LTV Electrosystems, Inc., Greenville, Tex.
A NOISE SUBTRACTIVE THRESHOLD DETECTOR
C. N. Kelly Jun. 1968 13 p
(G3681.02.05A)

Increased use of automatic receiving systems requires that a means of recognizing signal presence be provided. A means of providing this recognition is by thresholding at the receiver output and designating as signals all receptions above a preset voltage or power level. A unique solution to the problem of improving automatic signal presence detection is proposed in this paper together with the results of a computer simulation of the proposed technique. Computer simulation results are shown to compare favorably with those predicted by theory, and the simulation shows operation to be acceptable at levels of signal-to-noise ratio less than unity. An important feature of the detector is that energy detection is used making the results independent of the type of modulation received. Author

N68-26459# Institutt for Atomenergi, Halden (Norway). OEDC Halden Reaktor Prosjekt.
GAMMA THERMOMETER AND NEUTRON DETECTOR APPLICATION, 1964–1966
K. Svanholm Dec. 1967 33 p refs Sponsored in part by AEC
(HPR-73)

The paper reports on experience gained with gamma thermometers used as channel power detectors. The gamma thermometer has proved to be a reliable and rugged instrument. An accurate in-pile calibration must be carried out before it can be used directly as a channel power detector. Some tests have also been carried out with self-powered neutron detectors used as channel power detectors. The general merits of these two different types of detectors are described and in particular their behavior respective to control rod disturbance. Author (NSA)

N68-26497# Naval Ordnance Lab., White Oak, Md.
THE VIDEO TAPE RECORDING OF ULTRASONIC TEST INFORMATION
Robert A. Youshaw, Charles H. Dyer, and Edward L. Criscuolo 15 Feb. 1968 21 p refs
(NOLTR-68-13; AD-668165)

A video tape recorder has been converted into a wide band instrumentation recorder. The A scan from the ultrasonic tester is directly recorded, together with the operators voice giving the location, transducer position and interpretation of test data. An oscilloscope is used for the playback. The circuitry necessary to couple the output of the ultrasonic tester to the tape recorder is described. Author (TAB)

N68-26521# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
HIGH-TEMPERATURE VACUUM X-RAY CAMERA FOR STRUCTURAL INVESTIGATIONS OF METALS AND ALLOYS [WYSOKOTEMPERATUROWA KAMERA RENTGENOWSKA DO BADAN STRUKTURALNYCH METALI I STOPOW W PROZNI]
Zbigniew Beran, Stanislaw Banach, and Roman Czarnecki 1967 25 p refs In POLISH; ENGLISH summary
(INR-869/XIV/PS)

The high temperature, vacuum X-ray camera permitting Debye or Laue diffractograms from flat metallographic samples on a flat film is described. In the case of coarse polycrystalline samples the movement of the sample ascertains homogeneous intensity of Debye rings. The range of temperatures is from room temperature to 800°C. The stability and accuracy of the temperature measurement is ±5°C. The sample is placed in special holder and heated by radiation from an electric lamp (1000 watts), that is focused by a mirror on the sample. This method permits continuous regulation of the sample temperature by means of changing the power of the lamp. The great rate of sample heating 120°C/min, without introducing the heater into camera, is also obtained. High vacuum about $10-6$ mm of Hg in the camera gives the possibility of investigating the easy oxidizable specimens. The accuracy of the lattice constants measurements is about 0.005 Å. Author (NSA)

N68-26533 Brown Univ., Providence, R. I.
EXPERIMENTS IN HYDRODYNAMIC STABILITY
Richard Bowles Lambert, Jr. (Ph.D. Thesis) 1966 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-2257

A device called the Hot Thermistor Anemometer has been developed which is capable of measuring the shear stress exerted by a fluid on a solid surface bounding the flow. The design and calibration of the anemometer are described and it is then applied to the investigation of several types of secondary flow between rotating cylinders. An annulus of fluid with a free surface, differentially heated in the horizontal, has been successful to some extent as a model of the atmosphere. The baroclinic instability occurring in this model has been investigated as a function of the depth of the system. The effect of horizontal shear on the baroclinic waves has also been investigated. When an annulus of fluid between two long vertical cylinders is maintained isothermal, and the inner cylinder is rotated, the flow becomes unstable for a critical value of the rotation rate. A secondary flow is formed consisting of toroidal Taylor vortices which may or may not have azimuthal dependence. When the annulus is wide, no azimuthal dependence is found for Taylor numbers as high as 100 times the critical value. However, the generation of spatial harmonics and the formation of jets and shocklike structure is observed. Dissert. Abstr.

N68-26567# Battelle-Northwest, Richland, Wash.
CONSTRUCTION OF A RING-ELECTRODE VOID METER
Masahiro Satomi, Eio Ogasawara, and Shinichi Kashiwai [1967] 9 p refs Transl. into ENGLISH from Proc. of the 6th SICE Tech. Conf. p 515–518 Conf. held [Japan], 13–15 Oct. 1967
(AEC-TR-6930) CFSTI: HC $3.00/MF $0.65

An electron ring-electrode type void meter is described for measuring void fractions in the boiling water reactor. The meter was tested by measuring transient boiling voids and void fractions in high-speed, two-phase flow. NSA

N68-26590# Atomic Weapons Research Establishment, Aldermaston (England).
THE KRYPTON-85 LEAK TEST
J. L. Murgatroyd Mar. 1968 29 p refs
(AWRE-O-22/68) CFSTI: HC $3.00/MF $0.65

A description is given of the soak precedure and of the operation and calibration of the counting equipment used in the krypton-85 leak test for determining leak rates of evacuated tubes. It is shown that one may detect a minimum air leak rate of 10^{-12} atm cc sec $^{-1}$, the limit being set by the background radiation. The minimum activity which may be detected unambiguously by the apparatus is about 0.045 μCi. An account is given of the testing and results obtained on two alternative counting systems, calibrated by a typical shell filled with ^{85}Kr to an activity of 0.45 μCi ± 10%, the lowest activity standard available without too great a loss of dispensing accuracy. Author (NSA)

N68-26601# General Electric Co., Syracuse, N. Y. Heavy Military Electronics Dept.
MIRAGE 2 Final Report, 1 Jun. 1966–1 Apr. 1967
David V. Reinhardt, Sr. Griffiss AFB, N. Y. RADC Mar. 1968 232 p
(Contract AF 30(602)-4281)
(EH-61696; RADC-TR-67-441; AD-669143)

The MIRAGE (Microelectronic Radar Indicator for Ground Equipment) concept developed a 12-inch screen plan position indicator (PPI) almost exclusively with microelectronic components to reduce equipment size and weight and yet increase reliability and performance capability. The concept was fundamentally a result of the use of unique resolvers, or other electromechanical devices. The MIRAGE II, or now called AN/UPA-56, experimental model is two cubic feet in volume, weighs 70 lbs and requires 150 watts of power. This equipment represents a 5.3 to 1 power advantage, a 614 to 1 weight reduction of the existing transistorized comparable indicator. Most of the 640 integrated circuit packages used in the equipment are digital devices and the complete digital design is accomplished with only seven different circuit types. A ratio of integrated circuit type transistors to discrete types yields a 99.8% integration. Likewise, a ratio of integrated circuit type resistors and capacitors to discrete types yields a 94% integration. This almost blanket use of microelectronics results in an equipment mean time between failure rate (MTBF) of 2286 hours. MIRAGE II is considered to be a bench mark, its mechanical design emphasizing the particular parameters of small weight and volume. The use of integrated circuits presented no problems in the design, test, or manufacturability of the equipment. The recommendations are generally directed toward improving the techniques used rather than gross reduction. At the conclusion of this program, the AN/UPA-56 experimental model yielded a radar PPI ready for immediate field utilization. Author (TAB)

N68-26608# Sperry Rand Research Center, Sudbury, Mass.
A FEASIBILITY AND DESIGN STUDY FOR AN AIRBORNE RADIOMETRIC SYSTEM TO MEASURE REMOTELY THE VERTICAL PROFILE OF TEMPERATURE, HUMIDITY, AND PRESSURE Final Scientific Report, 1 Sep. 1966–30 Nov. 1967
Wayne D. Mount and B. Richard Fow Feb. 1968 60 p refs
(Contract AF 19(628)-6133)
(SRRC-CR-68-15; AFCRL-68-0107; AD-668086)

Microwave and infrared radiation from atmospheric oxygen and carbon dioxide was computed for different types of atmospheres. Functions were derived which specified the relative radiative contribution from different layers in the atmosphere and these functions were found to be reasonably constant for extreme atmospheric conditions. Methods were developed for remotely measuring the temperature and pressure height profiles from 100 mb to the surface. The infrared results were more accurate, giving a probable error of about 0.8 deg C as opposed to 1.0 deg C for the microwave. This difference in accuracy is not significant when compared against the far greater all weather capability obtained with the microwave technique. Errors in remote probing from 100 mb looking downward are the largest in the lowest layers of the atmosphere. Nevertheless, the analytical feasibility of remotely measuring the air temperature and pressure height profiles has been established with the results approaching that of ground-based radiosondes. Author (TAB)

N68-26610# American Inst. for Research, Pittsburgh, Pa.
IMPLICATIONS OF SYMBOL USAGE ON U.S. ARMY MAPS FOR AN AUTOMATED CARTOGRAPHIC SYSTEM Final Technical Report, May 1967–Feb. 1968
Walter R. Horner and Sanford P. Schumacher Feb. 1968 66 p
(Contract DAAK02-67-C-0456)
(AIR-G1-2/68-FR; AD-667979)

Since it is not economically feasible to produce by automatic means all standard AMS symbols in an automated cartographic system, it becomes important to know their relative frequency of use throughout the world. It is also pertinent to analyze these symbols with respect to system design and development, so as to provide criteria for decisions relative to assignments for production by automatic or manual methods to an operational system.
Author (TAB)

N68-26617# Aeroprojects, Inc., West Chester, Pa.
APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS Bimonthly Progress Report, 1 Dec. 1967–31 Jan. 1968
Feb. 1968 19 p refs
(Contract AT(30-1)-3622)
(NYO-3622-13; BMPR-38) CFSTI: HC $3.00/MF $0.65

The modified test loop at Mine Safety Appliance Research Corporation, (MSAR) is ready for evaluation of the ultrasonic incipient boiling detector. The ultrasonic flowmeter, using water as a simulant for liquid metal, has been calibrated and comparisons of current data with earlier data are given. In order to obtain more realistic data, a program using molten sodium for calibrating a flowmeter has been initiated. A test loop at MSAR is available and discussions are underway to design and install a flowmeter in this loop. Author (NSA)

N68-26620# Philco-Ford Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.
SPARK CHAMBER NEUTRON SPECTROMETER Final Report
8 Dec. 1966 135 p
(Contract AT(30-1)-3579)
(SRS-TR-3148; TID-24308) CFSTI: HC $3.00/MF $0.65

Design and operation of the spark chamber neutron spectrometer (SCNS) are presented. The SCNS detects neutrons and measures their energy within the 5 to 200 MeV range. Mechanical drawings and electronic schematics are included. Author (NSA)

N68-26637# Harry Diamond Labs., Washington, D. C.
M532 BATTERY TELEMETER
Gordon A. Nicolaisen Jan. 1968 30 p
(HDL-TM-68-2; AD-667950)

A completely self-contained three-channel telemetry system for testing fuze power supplies on artillery or mortar projectiles is described. The telemeter consists of a transmitter, three subcarrier oscillators, in-flight calibrator, battery, and signal-conditioning networks, all especially packaged to withstand linear accelerations up to 25,000 g and spin rates up to 22,000 rpm. Field tests indicate the telemeter performs reliably in this environment. Author (TAB)

N68-26665*# Emerson Electric Co., St. Louis, Mo. Electronics and Space Div.
RADIOACTIVE-TYPE DUAL ABLATION MEASURING SYSTEM, VOLUME 1 Final Report
John D. Bartley, Jr. 15 Jan. 1968 100 p refs
(Contract NAS1-5342)
(NASA-CR-66630; Rept.-2074) CFSTI: HC $3.00/MF $0.65
CSCL 14B

The feasibility of using a nucleonic technique for continuous and simultaneous measurement of ablative heat shield total and virgin material recession at the same flight vehicle location was investigated. The concept makes use of the chemical and nuclear properties of two radioactive compounds and of the fact that the radioactive intensity of these two compounds incorporated into an Ablation Sensor Plug, composed of the parent heat shield material, is related to the two thicknesses to be measured. Two radioactive chemical compounds were found, minute amounts of which could be incorporated into phenolic nylon and phenolic graphite without

altering the ablative properties of these heat shield materials. Ablation tests demonstrated that the intensity of radiation remaining of one compound, $ZrNb^{95}$, was proportional to the total heat shield thickness while that of the other compound, In^{114m}, was proportional to the virgin material thickness remaining. Author

N68-26680# Air Force Cambridge Research Labs., Bedford, Mass.
ERROR ANALYSIS OF THE HUMIDITY–TEMPERATURE MEASURING SET, AN/TMQ-11
Bernard D. Weiss Mar. 1968 110 p refs *Its* Instrumentation Papers, No. 140
AFCRL-68-0154; AD-669095)

The report discusses the results of tests performed at AFCRL to determine how closely the AN/TMQ-11 agrees with the ML-592. The analysis presented is based on 1769 observations obtained under field conditions from 1 November 1966 to 1 September 1967. The tests indicate that a negative bias error exists in the AN/TMQ-11 lithium chloride Honeywell and Foxboro dewpoint sensor(s). If the dewcel readings are adjusted to compensate for this bias, dewpoint temperatures can be accepted as indicated approximately 90 percent of the time. Author (TAB)

N68-26703*# Stanford Research Inst., Menlo Park, Calif.
CRYOGENIC MAGNETOMETER DEVELOPMENT Final Report, 1 Jul. 1964–7 Mar. 1967
William S. Goree, Bascom S. Deaver, Jr., V. W. Hesterman, and T. W. Barbee, Jr. Washington NASA Jun. 1968 72 p refs
(Contract NAS2-2088, SRI Proj. PHU-5093)
(NASA-CR-1073) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A low field superconducting shield has been developed and used to provide stable magnetic fields of less than 10^{-6} G, maintained stable for as long as 6 days. The shield is a superconducting cylinder 91.5 cm long by 16.5 cm ID. The measured attenuation of externally applied axial field changes is a factor of 31 per shield radius. The Meissner effect and zero resistance property of superconductors has been used in the development of a magnetometer for measuring the absolute value of magnetic fields. This device has been used to measure fields as small as 2×10^{-6} G. A magnetometer utilizing the unique zero resistance and quantized flux properties of superconductors has been developed and used to measure magnetic field changes as small as 5×10^{-7} G. The dc Josephson tunneling effect has been used to construct (1) magnetometers with field sensitivity as good as 10^{-7} G, (2) magnetic gradiometers with which field gradients of 10^{-8} G cm have been measured, (3) linear displacement detectors with which displacements of less than 1500 Å have been measured, and (4) a system for measuring static magnetic susceptibility, which was used to study the time dependence of the Meissner effect in hollow tin cylinders. Author

N68-26711# Army Materials and Mechanics Research Center, Watertown, Mass. Materials Testing Lab.
LIQUID SURFACE LEVITATION USED AS A MEANS OF ULTRASONIC IMAGE CONVERSION FOR MATERIALS INSPECTION
Otto R. Gericke and Robert C. Grubinskas Mar. 1968 25 p refs
(AMMRC-TR-68-06; AD-667934)

An ultrasonic image conversion cell utilizing the liquid surface levitation effect has been developed for nondestructive testing. This effect is based upon the principle that the surface of a free liquid will be deformed in accordance with the cross-sectional intensity distribution of an impinging ultrasonic beam. It can be coupled directly to an ultrasonically excited test specimen to obtain characteristic liquid-surface relief patterns depicting internal discontinuities. A significant advantage of the conversion cell is the fact that it does not require the test specimen itself to be immersed in a liquid. Also, because the conversion cell produces a real-time image, pulsed, frequency-modulated, and continuous wave modes of ultrasonic excitation can be used, and thus various types of ultrasonic images can be obtained. Author (TAB)

N68-26758# Uppsala Univ. (Sweden). Inst. of Physics.
OPTICAL PROPERTIES OF SCINTILLATION DETECTORS INVESTIGATED BY MEANS OF A COMPUTER PROGRAM
F. Falk, W. Sjoberg, and P. Sparrman Jan. 1968 19 p refs
(UUIP-568)

A computer program for evaluating the influence of optical parameters on the properties of scintillation detectors (scintillator + lightguide) is described. The detectors considered are cylindrically symmetric. The results of the calculation made for several differently designed scintillator–lightguide assemblies indicate that the geometrical design and the reflective coating of the scintillator have dominant influence on the performance of the assembly. Author (NSA)

N68-26789# Arizona Univ., Tucson.
AN F/2 FOCAL REDUCER FOR THE 60-INCH U. S. NAVAL OBSERVATORY TELESCOPE
A. B. Meinel and G. W. Wilkerson 28 Feb. 1968 63 p refs
(Contract Nonr-2173(12))
(TR-7; AD-668383)

The report deals with the development of a relay system--from telescope to collimator to grating (and/or filter) to high-speed camera--in order to speed up exposure time by a factor of about 20 for the U.S Naval Observatorys largest telescope, which is at Flagstaff, Arizona. The primary mirror is a 60-inch-diameter paraboloid. Author (TAB)

N68-26790# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
COMPTON SUPPRESSION USING PULSE-SHAPED DISCRIMINATION AND ANTICOINCIDENCE TECHNIQUES
K. L. Swinth, L. D. Philipp, and N. C. Hoitink [1967] 17 p refs Presented at the 11th Scintillation and Semiconductor Counter Symp., Washington, D. C.
(Contract AT(45-1)-1830)
(BNWL-SA-1515; CONF-680207-3) CFSTI: HC $3.00/MF $0.65

The suppression of the background continuum in solid-state detectors by anticoincidence and/or pulse-shape discrimination aids in the interpretation of spectra and enhances the peak-to-Compton ratio. Studies were performed with both ^{137}Cs and ^{59}Fe sources. For the ^{59}Fe source, an average reduction of 85% in the continuum resulted using a planar diode 110 mm^2 by 2.4 mm deep in an anticoincidence annulus of NaI(Tl). Both the distribution and number of events rejected varied with the amplifier shaping time constants. Results are compared with those obtained by other investigators. Author (NSA)

N68-26802# Atomic Power Development Associates, Inc., Detroit, Mich.
A PROPOSED PROGRAM FOR THE DESIGN AND DEMONSTRATION OF A PROTOTYPE UNDER-SODIUM ULTRASONIC SCANNER
J. Matte, III Feb. 1968 41 p refs
(Contract AT(11-1)-865)
(APDA-220) CFSTI: HC $3.00/MF $0.65

The applicability to large Na-cooled reactors of the undersodium ultrasonic transducer is shown to depend on the development of mechanisms suitable for accurate and versatile manipulation of the transducer within the reactor. A program of prototype design and testing is proposed to demonstrate the feasibility and desirability of such a device for eight typical applications to such reactors. The functional requirements of a prototype scanner and of a suitable

demonstration test rig are presented, together with brief descriptions of initial concepts of the prototype and the test rig. The proposed program of demonstration tests is outlined, together with the basis for evaluating the prototype performance in each application. Author (NSA)

N68-26824# California Univ., Livermore. Lawrence Radiation Lab.
DETECTOR HANDBOOK
Aug. 1967 150 p refs
(Contract W-7405-ENG-48)
(UCRL-50176) CFSTI: HC $3.00/MF $0.65

Topics discussed include photodiode linearity and saturation data, calibration techniques, fluors and radiators, test light systems, logarithmic detectors, Compton detectors, photomultiplier detectors, photodiode detectors, and solid state detectors. NSA

N68-26926# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A STUDY OF ACOUSTIC MONITORING OF THE GUN PROBE SYSTEM
Walter S. Nordquist, Jr. Nov. 1967 63 p refs
(ECOM-5166; AD-667917)

A single array acoustic sensor system has been used to detect the various acoustic events associated with a series of seven firings of the Atmospheric Sciences Laboratory gun probe at White Sands Missile Range, New Mexico. The acoustic events detected included launch, grenade explosion, and acoustic signals associated with the descent of various parts of the projectile. The results are presented by type of event and individual round and are compared to the available radar and optical tracking data. The results indicate that an acoustic system can be used to locate certain events occurring at horizontal ranges of fifteen to twenty miles with accuracies of a few hundred feet. Some of these events are of a nature which neither radar nor optical systems can recognize. Author (TAB)

N68-26938# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
PERFORMANCE OF A 3.3-MM RADIOMETER
Walter A. Johnson Feb. 1968 24 p refs
(Contract F04695-67-C-0158)
(TR-0158(3230-46)-13; SAMSO-TR-68-136; AD-668108)

The performance of a 3.3-mm radiometer, operational in the Space Radio Systems Facility of the Aerospace Corporation since December 1963, is described, and a criterion for judging the long-integration time performance of the radiometer is discussed. This criterion is applied to a study of radiometer output noise; from the results, it is inferred that the output noise spectral distribution is flat from approximately 0.0005 to a few Hz. Author (TAB)

N68-26943# Royal Aircraft Establishment, Farnborough (England).
A CONTRIBUTION TO RECORDING AND REPRODUCTION WITH THE NRZ METHOD [BEITRAG ZUR AUFZEICHNUNG UND WIEDERGABE BEIM NRZ VERFAHREN]
Karl Uhl Feb. 1968 13 p refs Transl. into ENGLISH from IEEE Trans Magnetics, v. 2, no. 3, 1966 p 221–224
(RAE-LIB-TRANS-1293) CFSTI: $3.00

In order to derive an expression for the reproduce head output when digital information is recorded on magnetic tape, measurements were made to determine the profile of the magnetization throughout the oxide thickness. A comparable curve is obtained from measurements made when thin coatings are used to space the oxide at varying distances from the head. It is shown that this curve is approximately a straight line, and it is assumed that the value of the magnetization inside the coating depth is constant. An expression is formulated for the output pulse as a function of gap length, coating thickness, and tape to head spacing. A parameter for the slope of the magnetization profile is established. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N68-25673# College of Aeronautics, Cranfield (England). Dept. of Materials.
THE ROLE OF DUCTILITY IN HOT WORKING
W. J. McG. Tegart Nov. 1967 50 p refs Presented at ASM Seminar on Ductility: Limitations, Exploit., Util., Cleveland, 14–15 Oct. 1967
(COA-Note-Mat-14) CFSTI: HC $3.00/MF $0.65

Strength and ductility are the important characteristics which govern the hot working properties of a material. This paper describes test methods for measuring hot workability and then discusses deformation and fracture mechanisms in hot working. Particular emphasis is laid on the correlation of strength and ductility data in simple materials in terms of dependence on strain rate and temperature. Suitable correlations enable the identification of basic parameters controlling deformation and fracture processes. With complex materials, these correlations cannot be applied due to the occurrence of precipitation reactions and the presence of inclusions and second phases having markedly different strength and ductility characteristics. Author

N68-25702# Sandia Corp., Albuquerque, N. Mex.
TABLE OF GEAR RATIOS 36.0000 TO 5.1449
Robert L. Lachance and Ralph M. Rayner Mar. 1968 174 p ref Sponsored by AEC
(SC-M-68-63) CFSTI: HC $3.00/MF $0.65

A series of gear ratios from 36.0000 to 5.1449 was compiled primarily for a three-step transmission filament-winding machine. Author (NSA)

N68-25716*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PROBLEMS OF INCREASING THE RELIABILITY OF AUTOMATIC MINING EQUIPMENT
L. G. Mel'kumov and V. B. Ginzburg Redstone Arsenal, Ala. Redstone Sci. Inform. Center 19 Apr. 1968 17 p Transl. into ENGLISH from Mekhaniz. i Avtomatiz. Proizv. (Moscow), no. 7, 1966 p 50–52 Prepared by Army Missile Command
(NASA-TM-X-61123; RSIC-786) CFSTI: HC $3.00/MF $0.65
CSCL 13I

Discussed are problems of reliability of automation equipment in coal mines. Special emphasis is placed on the actual operating reliability of the equipment, the nature of possible breakdown, and recommendations for improving reliability. Author

N68-25797# Central Mechanical Engineering Research Inst., Durgapur (India).
A NEW TEST DUST FOR FUEL FILTERS
B. Kanaka Raju, P. Chenchanna, and V. Subba Rao Nov. 1967 15 p refs
(A11) CFSTI: HC $3.00/MF $0.65

The report describes the composition and method of production of Merit dust for evaluating automobile fuel filters. Results of a comparative study of the performances of Bosch and Merit dusts are presented in detail. It is shown that Merit dust can conveniently replace Bosch dust for testing fuel filters. Author

N68-25798# Central Mechanical Engineering Research Inst., Durgapur (India).
SHOCK ABSORBER TEST RIG
S. N. Bhagi Nov. 1967 11 p refs
(A12) CFSTI: HC $3.00/MF $0.65

The test rig for testing road spring vibration dampers is described along with the various methods for using the rig. Author

N68-25811# Central Mechanical Engineering Research Inst., Durgapur (India).
REFERENCE BLOCKS FOR ULTRASONIC TESTING OF ENGINEERING MATERIALS
S. G. N. Swamy and P. C. Mahajan Dec. 1967 29 p refs
(A14) CFSTI: HC $3.00/MF $0.65

The authors discuss the superiority of IIW block over the various other calibration blocks developed and used in different countries, and summarise the know-how developed on the precise use of IIW block for calibration of ultrasonic testing equipment. The calibration and comparison blocks developed at CMERI are also discussed, and their operational techniques are given. Author

N68-25831*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
WELD FLAW DETECTION EVALUATION UTILIZING ULTRASONICS AND RADIOGRAPHY
G. W. Kurtz 10 May 1968 53 p refs
(NASA-TM-X-53700) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The results of a research program evaluating ultrasonics in the detection of aluminum butt weld flaws common to Saturn V S-IC Stage welds are presented. Comparisons were made with radiographic test results on the same welds. Flaws investigated were lack of penetration, lack of fusion, porosity, slag inclusions, and a brief investigation of weld bead interference. The advantages of ultrasonics over radiography, except in the case of porosity, were demonstrated. Author

N68-25847# Rocky Flats Div., Dow Chemical Co., Golden Colo.
MATERIALS FOR HIGH-TEMPERATURE METAL-MELTING CONTAINERS
Wendell P. Meier 21 Feb. 1968 11 p refs
(Contract AT(29-1)-1106)
(RFP-900) CFSTI: HC $3.00/MF $0.65

A method is described for developing pressure-sintering techniques for use in the fabrication of high-temperature metal-melting containers. The pressure-sintered materials included tungsten, zirconium diboride, and various oxides, nitrides, and carbides. These materials were formed into containers of high density and low porosity by pressure sintering. Author (NSA)

N68-25964# Titanium Metals Corp. of America, West Caldwell, N. J.
PREPARATION AND AVAILABILITY OF MILL PRODUCTS
Robert L. Kane *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 13–19 (See N68-25961 15-17)

Grades of titanium frequently used in the process industry are tabulated, and price and volume aspects of preparing titanium are noted. Availability of various titanium mill products is considered, including ingots, plates, sheets and strips, bars and wires, and castings. Several illustrations indicate various parts of the production process and the end products; and a flow chart illustrates the procedure for ore reduction, sponge production, and ingot production into mill operations and finished products. M.W.R.

N68-25965# Metcut Research Associates, Inc., Cincinnati, Ohio.
MACHINING TITANIUM ALLOYS
Norman Zlatin *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 20–25 refs (See N68-25961 15-17)

Machining characteristics of various titanium alloys are discussed; and recommended conditions are tabulated for machining titanium 8A1-1Mo-1V during the turning, face milling, peripheral end milling, end mill slotting, drilling, reaming, and tapping operations. It is noted that the machining characteristics of the titanium alloys range from fairly good for the alpha type to poor for beta type. Relationship between cutting speed and tool-tip temperature with carbide tools is graphed, and machining ratios for four types of titanium alloys are compared with that for AIS 4340 steel when the carbide tool was used during turning and face-milling and when high-speed steel drills were used during drilling. M.W.R.

N68-25966# Du Pont de Nemours (E. I.) and Co., Wilmington, Del.
WELDING TITANIUM FOR CHEMICAL PROCESS EQUIPMENT
R. B. Hitchcock *In* Batelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 26–28 (See N68-25961 15-17)

Titanium welding is discussed in terms of chemical process equipment; and attention is given to tungsten inert gas (TIG) and consumable electrode gas shielding welding as well as to fusion welding titanium in an expendable inert gas chamber. Typical joint configurations and parameters for TIG welding titanium are given, and it is noted that the actual welding details for titanium are practically the same as for stainless steel. A butt weld in titanium clad steel is shown. M.W.R.

N68-26035# Technische Hochschule Munchen (West Germany).
INVESTIGATION OF HELICON GEARS AND SPIROID GEARS WITH TRAPEZOIDAL WORM PROFILE ACCORDING TO THE HERTZIAN AND THE HYDRODYNAMIC THEORIES [UNTERSUCHUNG VON HELICON- UND SPIROID-GETRIEBEN MIT TRAPEZFOERMIGEN SCHNECKENPROFIL NACH DER HERTZSCHEN UND NACH DER HYDRODYNAMISCHEN THEORIE]
Dietrich Schwaegerl (Ph.D. Thesis) 14 Dec. 1967 27 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Spiroid and helicon gears are analyzed and compared for: (1) transfer moments caused by Hertz pressure; (2) transfer moments caused by lubricant pressure; (3) hydrodynamic power loss; and (4) hydrodynamic efficiency. Computer calculations in ALGOL for the various gear wheels show that the spiroid gears reached higher transfer moments through Hertz and lubricant pressures than the helicon gears; this effect is even more pronounced at smaller trailing edge angles. However, efficient power output for any spiroid gear requires a balanced relation between front face angle and trailing edge angle. Transl. by G.G.

N68-26127*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A REVIEW OF THE EARLY USE OF MOLYBDENUM DISULFIDE AS A LUBRICANT
Robert L. Johnson Washington 1967 31 p Presented at Natl. Lubricating Grease Inst. Ann. Meeting, New Orleans, 29 Oct–1 Nov. 1967
(NASA-TM-X-52343) CFSTI: HC $3.00/MF $0.65 CSCL 11H

The major use of MoS_2 as a lubricant was developed in the last 25 years, however, there is evidence of its use for several centuries. The early technical literature and patent history on MoS_2 are described and concepts on the behavior of MoS_2 are explained. Further, methods of using MoS_2 in bonded solid films, in situ formed films, low concentration liquid mixtures, pastes, greases and solid composites are discussed in general. Author

N68-26197*# Boeing Co., Seattle, Wash. Launch Systems Branch.
EVALUATION OF RETENTION METHODS ON MBC 455 CONNECTOR CONTACTS
C. A. Guidry 1967 18 p
(Contract NAS8-5608)
(NASA-CR-61803; T5-6539-97) CFSTI: $3.00 CSCL 13E

An unwired contact was found dislodged from an MBC 455-1 connector in a S-1C-5 vehicle distributor and was reported on UER 235513. An investigation revealed that some contacts could be pushed out of the connector with a force lower than that which might be experienced during distributor assembly operations. Author

N68-26235 Michigan Univ., Ann Arbor.
HIGH SPEED PHOTOGRAPHIC STUDIES OF ULTRASONICALLY INDUCED CAVITATION AND DETAILED EXAMINATION OF DAMAGE TO SELECTED MATERIALS
Hilding Gunnar Olson (Ph.D. Thesis) 1966 348 p
Available from Univ. Microfilms: HC $15.75/MF $4.45 Order No. 67-8319

The purpose of this study is to explore the many facets of cavitation as induced by high frequency vibration in water, and to present a comparison, when possible, to data accumulated from venturi and previous vibratory experiments. High speed photographic techniques have been developed and used to study the bubbles that make up the ultrasonically-induced cavitation cloud. Individual cavitation pits have been examined metallographically and their profiles traced. Photographic proof has been obtained that most bubbles in an ultrasonically-induced cavitation field are expanded and collapsed in one acoustic cycle. Collapse or rebound of the secondary cavitation causes shock waves resulting in circular areas which are free of bubbles. This is the type of collapse that is believed to provide the fundamental damaging mechanism. An attempt was made to correlate mean depth of penetration, depth to diameter ratio, and bubbles per pit ratio to various mechanical properties of the specimens. The use of the vibratory facility to rate materials for cavitation resistance faces limitations in that the rating of materials is strongly dependent on the bubble population and the changes that occur in this population due to surface damage brought on by pitting. Dissert. Abstr.

N68-26350# Martin Co., Denver, Colo.
CENTER FOR HIGH ENERGY FORMING Quarterly Technical Progress Report
JD. Mote 1 Apr. 1968 31 p refs Prepared jointly with Denver Univ.
(Contract DA-19-066-AMC-266(X); ARPA Order 720)
AMRA-CR-66-05/13; QTPR-11; AD-668243)

Strain gage data showing strain- and pressure-time histories versus charge stand-off during explosive deformation is given. The results show a decrease in strain rate with an increase in stand-off at constant charge weight. Recent results of a numerical solution for deformation and instability in the hydrostatic bulge test are presented. Summary information is presented for technology transfer; mechanics of energy transfer and high velocity metal deformation; electromagnetic forming; strain rate effects; the effect of explosive forming on the terminal properties of materials, and explosive welding. Author (TAB)

N68-26365# Columbia Univ., New York. Lubrication Research Lab.
REVIEW OF NUMERICAL METHODS IN GAS BEARING FILM ANALYSIS
V. Castelli, and J. Pirvics Feb. 1968 82 p refs
(Contract Nonr-266(88))
(Rept.-11; AD-668500)

The application of numerical methods to gas bearing problems is of great importance in view of the difficulties encountered by purely analytical methods in dealing with the non-linear character of the governing equations and complicated details of practical geometries encountered. The past ten years have witnessed marked progress in computer technology with accompanying development of numerical analysis. The report presents the best techniques which are applicable to gas bearing systems. Author (TAB)

N68-26462# General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.
CONTAMINATION CONTROL IN HIGH VACUUM PROCESSING
H. A. Hamilton 1 Mar. 1968 15 p refs Presented at Am. Assoc. of Contamination Control Rio Grande Chapter Meeting, Albuquerque, N. Mex., 1 Mar. 1968
(Contract AT(29-2)-656)
(GEPP-21) CFSTI: HC $3.00/MF $0.65

Contamination control has a twofold relationship to high vacuum processing. The use of varying levels of vacuum in processing operations represents the most sophisticated current technique for controlling contamination in critical processing. Its use in the vacuum firing mode represents the ultimate in parts cleaning for many applications. Conventional contamination control techniques are an essential foundation for the successful maintenance and operation vacuum equipment. This paper explores the relationship of conventional contamination control and high vacuum procedures, and develops the potential for the use of these vacuum processes. Author (NSA)

N68-26468# European Atomic Energy Community, Ispra (Italy). Engineering Dept.
FABRICATION AND PROPERTIES OF CHEMICAL VAPOR DEPOSITED Nb LAYERS ON Al_2O_3 BODIES FOR THERMIONIC APPLICATION
P. Fiebelmann Brussels Feb. 1968 29 p refs
(EUR-3743.E)

A recently developed CVD process for refractory metal plating is of interest as regards the fabrication of Nb–Al_2O_3–Nb sandwiches for thermionic application. The process uses Zn for the reduction of refractory metal chlorides. Nb deposition is in accordance with the reaction: $2\ NbCl_5 + 5Zn \rightarrow 5\ ZnCl_2 + 2\ Nb$. A laboratory apparatus for plating Al_2O_3-tubes is described and working data given. The influence of pressure and temperature change is discussed, as well as the most important factors to be considered in the plating procedure. Results relating to the layer-properties are shown. The main features after outgassing at 1650°C are: chemical purity, good surface adherence even during sharp thermal cycles, and equal layer thickness. For application in the 800 to 1100°C temperature range, brazing and diffusion bonding of Nb-plated Al_2O_3 bodies proved feasible. Related results are also reported. Author (NSA)

N68-26491# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MACHINE BUILDING (SECTION 43 AND 44)
V. P. Romanovskiy 18 Sep. 1967 22 p Transl. into ENGLISH from Mashinostr. (Moscow), 1965 p 393–402
(FTD-MT-67-55; AD-668512)

Section 43 of the article briefly reviews four basic methods of bending shaped blanks and cites examples of appropriate use of each method. Section 44, entitled Press Works briefly categorizes operations which are included under this title. Such operations include: (1) pressing on press lathes; (2) press-rolling on rolling lathes; (3) crimping, flanging, and edgecutting on special vertical two-spindle crimping machines. Author (TAB)

N68-26510*# Battelle Memorial Inst., Columbus, Ohio.
FEASIBILITY STUDY OF RESISTANCE WELDING OF ALUMINUM ALLOYS, STAINLESS STEEL, AND TITANIUM IN A HARD VACUUM Final Report, 27 Jun. 1967–29 Feb. 1968
D. L. Cheever, D. G. Howden, and R. E. Monroe 29 Feb. 1968 38 p refs
(Contract NAS8-21196)
(NASA-CR-61408) CFSTI: HC $3.00/MF $0.65 CSCL 13H

An investigation was made of the feasibility of resistance spot welding 2014 aluminum, 304 stainless steel, and Ti–6Al–4V alloy in a hard vacuum. The program was carried out in four phases, which consisted of planning the experimental program and physical equipment, making weldments both in air and in vacuum using conventional resistance welding techniques, and determination of the tensile shear strength of the welds. In addition, the data were analysed to show in what ways welds made in air differed from those made in a vacuum. The resulting graphs provide guidelines for determining welding conditions in space once the welding conditions in air are known. A final analysis of the program results was performed to determine what function and capabilities would be required for spot welding in space. A discussion of desirable features and recommendation of guidelines for equipment design was also included. The data from the program provided criteria for the design of portable spot-welding equipment to be used in joining materials in space. Author

N68-26564*# Rocketdyne, Canoga Park, Calif. Engineering Dept.
FABRICATION TECHNIQUES FOR SHROUDED TITANIUM IMPELLER Quarterly Progress Report
N. A. Edlebeck 1 Jan. 1968 44 p
(Contract NAS8-20761)
(NASA-CR-61450; LAP-68-9(RC); QPR-2) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Effort on fabrication techniques of a shrouded titanium impeller was directed toward completion of the detail design drawings for full size hardware fabrication. Major effort was also placed on fabrication and diffusion bonding of simulated impeller samples to determine, and then eliminate, possible problem areas that could arise in bonding of the full size impeller assembly. Detail drawings for the impeller pre-bond assembly were also completed. Fabrication of six test specimens and tooling was completed to determine the optimum bonding temperature and pressure for titanium alloy (5 Al 2.5 Sn). Author

N68-26570# Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF PRACTICE FOR COMPOSITE ROLLING OF STRUCTURAL METAL PANELS Quarterly Report, 15 Nov. 1967–15 Feb. 1968
J. R. Van Orsdel, D. N. Williams, and E. S. Bartlett Apr. 1968 15 p
(Contract DA-19-066-AMC-308(X))
(AMMRC-CR-66-02/7; QR-7; AD-668244)

Continued roll-bonding experiments with the nickel-base alloy Rene 41 are described. Variables studied included rolling temperature, reduction per pass, and cleaning procedures including vacuum outgassing at high temperature. Metallographic examinations of the beryllium stiffener fabricated into the skin sheet of the B120VCA titanium alloy during the last quarter showed the beryllium to be badly cracked. Fabrication of composite-filler bars for pilot-size pack lay-ups was completed. TAB

N68-26625# Marquardt Corp., Van Nuys, Calif. Materials and Process Dept.
INVESTIGATION OF FABRICATION PROCESSES AND NEW MATERIALS FOR ADVANCED AEROSPACE APPLICATIONS
J. A. Astorian, H. Binder, R. D. Lloyd, and E. E. Ritchie May 1967 54 p refs
(S-585)

A three part program was conducted to advance the state-of-the-art of new materials and fabrication processes applicable to present and future aeropropulsion concepts. The program involved conducting fabricability studies, joining studies, and mechanical property determinations of two relatively new alloys: the 9Ni–4Co (iron base) alloy and Be–38%Al (Lockalloy). The results of these investigations indicated the desirability and limitations of each alloy which will be of significant value in considering them for future specific designs. The third program consisted of hot forging and cold working studies of L-605, a cobalt base superalloy useful for combustion chambers, tail pipes, etc. The results of this work were of significant value in optimizing fabrication parameters for such applications. Author

N68-26660*# Boeing Co., Seattle, Wash. Launch Systems Branch.
FAILURE ANALYSIS OF ACTUATOR BOOT FITTINGS
F. G. Schoen [1967] 15 p refs
(Contract NAS8-5608)
(NASA-CR-61811; T5-6539-104) CFSTI: $3.00 CSCL 13E

Servoactuator boot fittings, P/N 60B21146 -1 and -2, failed by cracking on the S-IC-502 vehicle at KSC. Subsequent analysis revealed that the parts had not been shimmed on assembly and resultant high installation stresses induced stress corrosion cracking in the saline atmosphere at the Space Center. It also developed that an E.O. against the assembly drawing required shimming an all vehicle except the 502. This suggests that this type of failure would be peculiar to this stage. New units, same part numbers as above, were procured and installed with proper shimming to eliminate installation stresses and also reduce the possibility of stress corrosion. Author

N68-26661*# Boeing Co., Seattle, Wash. Launch Systems Branch.
METALLURGICAL ANALYSIS OF BACB30GZ8 FASTENER FAILURES, 504 VEHICLE FUEL TANK
C. B. Schwartz [1967] 20 p ref
(Contract NAS8-5608)
(NASA-CR-61813; T5-6539-99) CFSTI: $3.00 CSCL 13E

Unplanned Event Records U272346, July 15, 1967 and U272353 July 16, 1967 reported a total of eleven fastener fragments discovered during the post static firing inspection of the 504 Vehicle Fuel Tank. These fragments were identified as being from seven fasteners. All failures were found to be caused by stress corrosion. The recommendations of T5-6539-93, "Metallurgical Analysis of a BACB30GZ8-6 Fastener Failure, 503 Vehicle Fuel Tank" should be followed, i.e., remove unfavorable grain pattern to raise the stress corrosion threshold, or use a collar which induces a preload below the existing corrosion threshold. Author

N68-26681# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE EFFECT OF TRANSMITTING MEDIA ON THE FORMING OF SHEET METALS IN EXPLOSIVE FORMING

[VLIYANIYE PEREDAYUSHCHIKH SRED NA FORMOOBRAZOVANIYE LISTOVYKH METALLOV PRI VZRYVNOM DEFORMIROVANII]

E. B. Medzyanovskiy 30 Jun. 1967 14 p refs Transl. into ENGLISH from Kuznechno-Shtampovochnoye Proizv. (USSR), no. 4, 1965 p 25–28
(FTD-HT-67-8; AD-668065)

AMg6M aluminum-base alloy sheets 2 mm thick were subjected to explosive forming using water, sand, and rubber as transmitting media in a spherical die 120 mm in diameter. To determine the effect of shock waves reflected from container walls, forming was done in a permanent container, a thick-walled cylinder, and in single-shot polyethylene or resin-impregnated glass cloth containers. By varying the weight of the explosive charge, the specimens were deformed until cracks appeared. It was found that forming with sand required an explosive charge 4.5-5.0 times larger than forming with water for a cavity of the same size. The distribution of the maximum deformation and maximum curvature and the nature and location of ruptures along the profile of the deformed blanks were appreciably different in forming with water, sand, and rubber. Author (TAB)

N68-26683# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF LOW CAPACITY HIGH PRESSURE STAGES OF CENTRIFUGAL COMPRESSORS [ISSLEDOVANIYE MALORASKHODNYKH V YSOKONAPORNYKH STUPENEY TSENTROBEZHNYKH KOMPRESSOROV]

S. A. Anisimov, Yu. B. Galerkin, and F. S. Rekstin 13 Sep. 1967 26 p refs Transl. into ENGLISH from Tr. Leningr. Politekhn. Inst. (Moscow), no. 228, 1963 p 63–78
(FTD-MT-24-174-67; AD-668066)

In view of the importance to contemporary turbocompressor design of increasing the efficiency of low-capacity, high-pressure, centrifugal compressors, and the difficulties engendered by the small discharge volumes, the paper summarizes and evaluates the results obtained in tests of such compressor stages. Tests were carried out on 9 configurations of intermediate stages (impeller-diffuser-return bend and channel) and 3 configurations of terminal stages (impeller-diffuser). All the impellers had a relative width b2/D2 of approximately 0.02; the intermediate stage impellers had a diameter D2 of 352 mm and were tested at tip speeds of 300-315 m/sec., while the terminal stage impellers were 220-256 mm in diameter and were tested at 198-229 m/sec. Three types of diffusers (channeled, vaned and vaneless) were used for the intermediate stages, while the terminal stages were tested only with vaned diffusers. The effectiveness of a particular stage was evaluated on the basis of the stage efficiency, impeller efficiency, diffuser efficiency, stage pressure coefficient, stage pressure ratio, impeller pressure ratio, drag coefficient of the stationary parts, relative loss coefficient of the stagnation pressure, degree of reaction, Mach number, Reynolds number, flow coefficient, discharge rate and the angles of incidence of flow. Author (TAB)

N68-26723# Naval Weapons Lab., Dahlgren, Va.

EXPLOSIVE WELDING (CLADDING) OF HIGH TEMPERATURE METALS TO HIGH STRENGTH STEELS First Phase Report

R. William Breitzig 25 Jul. 1965 25 p refs
(NWL-T-27/65; AD-668021)

AMS 6434 steel can be clad with columbium, molybdenum, tantalum/tungsten (90/10), and high nickel alloys by explosive welding when the steel surface to be welded has been knurled beforehand. Author (TAB)

N68-26766# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MACHINE BUILDING, CHAPTER 4

V. P. Romanovskiy 14 Sep. 1967 48 p Transl. into ENGLISH from Mashinostr. (Moscow), 1965 p 305–337
(FTD-MT-67-09; AD-668231)

This report on machine building is devoted to basic information on the topic of sheet forming. Sub-headings include: (1) relief forming; (2) flanging of holes and external contour; (3) high power forming; (4) stretching (hollow upsetting); (5) squeezing; (6) straightening. Typical examples are given in each category and basic techniques are described. Author (TAB)

N68-26772*# Boeing Co., Seattle, Wash. Launch Systems Branch.

ANALYSIS OF FAILED CONTACTS FROM METHODE CONNECTOR, FD-744-3S-SF

F. G. Schoen and D. W. Fitzwater [1967] 9 p refs
(Contract NAS8-5608)
(NASA-CR-61804; T5-6539-96) CFSTI: HC $3.00/MF $0.65 CSCL 13E

During an investigation of contact protrusion and misalignment in Methode FD744-3S-SF connectors, many cracks were found in the contacts, originating from the root of the retention tab. Findings revealed that tighter controls would be required, above those in Methode drawings to assure production of satisfactory parts. To this end MBC 455 was issued. Author

N68-26775# Uppsala Univ. (Sweden). Inst. of Physics.

A DEMOUNTABLE GLASS CIRCULATION PUMP WITH VARIABLE, HIGH PUMPING SPEED

John E. Gustavsson May 1967 13 p refs
(VVIP-547)

A glass circulation pump with a flow rate continuously variable from 0.8 to 8 liters per minute is described. The pressure difference is small, the maximum value being about 16 mm Hg. The pump is used for purification of the counting gas of an ionization chamber with a volume of 600 liters. It is of piston type, and the piston is made of a soft iron tube entirely covered with teflon. The piston is moved by a permanent magnet. The pump is demountable. The stroke length and the stroke frequency are continuously variable. Author (NSA)

N68-26803# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ROLLING OF METAL POWDERS

G. A. Vinogradov and Yu. N. Semenov 23 Jun. 1967 94 p refs Transl. into ENGLISH of the book "Prokatka Metallicheskikh Poroshkov" Moscow, Metallurgizd., 1960 p 1–88
(FTD-MT-67-67; AD-668029)

The book published in 1960 assembles and condenses current information on powder metallurgy and its possible applications to production heretofore achieved by casting methods. Roll compacting information has been collected from a wide range of sources and an attempt is made to synthesize the total knowledge in general terms. The book includes descriptions of flow diagrams, equipment for roll compacting, and the properties of rolled cermet materials. TAB

N68-26806*# Boeing Co., Seattle, Wash. Launch Systems Branch.

EVALUATION OF 3M'S Y-9050 TAPE FOR SEALING OPENINGS AT THE INTERTANK TO Y-RING JOINT

R. O. Koch [1967] 22 p
(Contract NAS8-5606)
(NASA-CR-61810; T5-6556-18) CFSTI: $3.00 CSCL 11A

Tests were conducted to determine the suitability of 3M's Y-9050 Tape for sealing openings at the Intertank-to-Y-Ring joint. Peel tests were conducted over a temperature range of 75° to −250°F. Also the leading edges of the tape were subjected to a blast of air (C≈75°F) to simulate the air flow encountered in flight. The performance of the tape was considered sufficient to meet Design Engineering requirements. Author

N68-26843*# Tennessee Univ., Knoxville. Dept. of Mechanical and Aerospace Engineering.
THEORETICAL AND EXPERIMENTAL STUDIES OF VISCO TYPE AND BUFFERED SHAFT SEALS Semiannual Progress Report, 15 Oct. 1967–15 Apr. 1968
William K. Stair, Charles F. Fisher, Jr., and Edison A. Picklesimer, Jr. May 1968 32 p refs
(Grant NsG-587)
(NASA-CR-94805; ME-68-587-11; SAPR-11) CFSTI: HC $3.00/MF $0.65 CSCL 11A

Performance results of four grooved-shaft seals are presented. These results, in addition to those for 23 geometries previously reported, indicate that the theory advanced provides a good design estimate for grooved-shaft viscoseals in both laminar and turbulent regions. The performance of large diameter viscoseals having the same geometric parameters is relatively insensitive to the length of the land-groove pair when operated in the turbulent region. The radial load-carrying capacity of a viscoseal was found to be 12% to 15% of the capacity of a full journal bearing of the same overall dimensions. Studies of interface stability have lead to a hypothesis for the mechanism of gas ingestion in viscoseals. Author

N68-26849*# Boeing Co., Seattle, Washington. Launch Systems Branch.
ANALYSIS OF TOOLING BOSS WELD FAILURE IN THE LOWER BULKHEAD OF THE S-IC-S FUEL TANK
F. G. Schoen [1967] 16 p refs
(Contract NAS8-5608)
(NASA-CR-61805; T5-6539-103) CFSTI: HC $3.00/MF $0.65 CSCL 13H

A section of the failed tooling boss weld from the lower fuel tank bulkhead of the S-IC-S fuel tank was analyzed. Failure occurred during the ultimate pressure test at a hydrostatic pressure of 62.5 psig. Hardness tests and metallographic analysis revealed that excessive heat was employed to produce the original weld and multiple repairs, which still contained large amounts of porosity after repair. The lessening of 2219/2319 aluminum alloy properties in the tooling boss weld area by excessive heating and weld porosities was significant enough to permit failure under ultimate test pressure conditions. Author

N68-26851*# Boeing Co., Seattle, Wash. Saturn Booster Branch.
FAILURE ANALYSIS OF DELRON INSERTS IN THE 60B20217-2 HEAT SHIELD PANEL
L. W. Teeter [1968] 10 p
(Contract NAS8-5608)
(NASA-CR-61809; T5-6785-2) CFSTI: $3.00 CSCL 13H

The inserts attaching the 60B20219 angle to the 60B20217-2 heat shield panel failed during the incorporation of ECP 0838 at Kennedy Space Center. The panel was rejected on UER270641 and returned to Michoud for analysis and corrective action. Author

N68-26856*# Boeing Co., Seattle, Wash. Saturn Booster Branch.
FLUOROSILICONE O RINGS IN GOX AT 500°F AND 1500 PSIG
J. W. Dunn [1968] 17 p refs
(Contract NAS8-5608)
(NASA-CR-61807; T5-6556-19) CFSTI: $3.00 CSCL 11A

Fluorosilicone "O" rings in three sizes were tested at 500°F and 1500 psig in pure oxygen/nitrogen for five minutes with a vibrational input, simulating conditions as found in an oxygen flow valve on the S-IC. Results indicated the rings did not fail from oxidation, but from mechanical attrition; leakage rates were used to determine integrity of the seal. Author

N68-26888*# Boeing Co., Seattle, Wash. Saturn Booster Branch.
METALLURGICAL ANALYSIS OF A 504 VEHICLE OXIDIZER TANK RING BAFFLE WEB, 60B12550-1 FAILURE
C. B. Schwartz [1968] 22 p refs
(Contract NAS8-5608)
(NASA-CR-61806; T5-6539-100) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The failure of an oxidizer tank ring baffle web was reported. Post static firing inspection of the 504 vehicle revealed the failure of a web in the first ring at position II of the lower bulkhead adjacent to the fill and drain port. Failure was attributed to the impingement of liquid oxygen, resulting in low and high cycle fatigue, initiating at minute stress corrosion cracks which were caused by rivet installation. The minute stress corrosion cracks found are localized conditions caused by rivet installation stresses. Normal usage will not cause the growth of these cracks by stress corrosion. Deflection of inflowing oxygen, greater control of liquid oxygen flow rate or the use of a heavier gage web should preclude the failure of ring baffle webs at this position. Author

N68-26940# Moscow State Univ. (USSR).
HIGH PRESSURE EFFECTS ON METALS (EXTRUSION OF METALS)
Moisei Abramovich Karev IZD. Znanie 1967 49 p ref In RUSSIAN
CFSTI: HC $3.00/MF $0.65

A survey is presented on the development of equipment and techniques for hydraulic extrusion treatment of metals under high pressure. The basic properties of solids are briefly discussed including: chemical composition, crystal structure, conductivity, free electrons, the forbidden band and Fermi surfaces, melting points, magnetic properties, and plasticity. Mention is also made of methods for attaining and measuring high pressure. Transl. by E.C.

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N68-25667# California Inst. of Tech., Pasadena. Quantum Electronics Lab.
NONLINEAR AND ANISOTROPIC EFFECTS IN MAGNETICALLY TUNED LASER AMPLIFIERS
Andrew Dienes Jun. 1967 242 p refs
(Contract AF 49(638)-1322)
(AFOSR-68-0671; SR-6; AD-667188)

The nonlinear characteristics of a gas laser amplifier operating with two optical frequency signals of arbitrary polarization and having an axial magnetic field is analyzed, using semiclassical radiation theory and a density matrix formalism. Both perturbational solutions, valid for relatively weak intensities and solutions valid for arbitrarily strong fields are obtained for two nonlinear effects: the saturation interaction of the electromagnetic waves, and the generation of combination tones. An arbitrary amount of doppler broadening is considered throughout. Author (TAB)

N68-25723*# Sylvania Electric Products, Inc., Mountain View, Calif.
STABILIZED CARBON DIOXIDE GAS LASER Final Report, 1 Dec. 1966–30 Jan. 1968
R. S. Reynolds 30 Jan. 1968 78 p refs
(Contract NAS5-10309)
(NASA-CR-95055) CFSTI: HC $3.00/MF $0.65 CSCL 20E

A CO_2 laser capable of high power at a single frequency, highly stabilized on the short term is presented. This laser has been developed for use in long range communications systems. The laser utilizes a master-oscillator, power-amplifier to achieve high power simultaneously with high stability and is capable of providing up to 38 watts of single-frequency light in the TEM_{00q} mode. A temperature-controlled oscillator provides 5 watts of power at a

single wavelength at 10.6 microns for an active plasma length of 50 cm. A second oscillator was used to obtain relative frequency stability information by heterodyne techniques. Long-term stability, as determined by the thermal environment was about ± 3 parts in 10^7. The short-term stability varied between 5 parts in 10^{11} and 1 part in 10^9 over a 10 ms time interval. The short-term frequency stability depends strongly on the laser acoustical environment. Experimental results are also presented on the effects of RF excitation, laser bore size and gas mixture on the laser output. Author

N68-25735*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

DESIGN AND PERFORMANCE OF GEOS-B LASER DETECTOR

Peter O. Minott Oct. 1967 67 p

(NASA-TM-X-63222; X-524-67-512) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The report describes the design and performance of the laser detector employed in the Atmospheric Laser Scintillation Experiment aboard the GEOS-B satellite. The laser detector was designed and fabricated for Goddard Space Flight Center by Washington Technological Associates, Inc. of 979 Rollins Avenue, Rockville, Maryland 20852. Many of the graphs, and drawings used in this report are derived from work done by WTA. Four laser detectors were fabricated and are referred to as units number 1, 2, 3, and 4 in this report. Unit number 2 was installed on the GEOS-B satellite. Author

N68-25753*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

HYDROGEN STANDARD WORK AT GODDARD SPACE FLIGHT CENTER

H. E. Peters, T. E. McGunigal, and E. H. Johnson May 1968 35 p refs

(NASA-TM-X-63223; X-523-68-152) CFSTI: HC $3.00/MF $0.65 CSCL 20E

This paper reviews hydrogen standard work at GSFC during the past two years. Research and development has been directed primarily toward the realization of field operable time and frequency standards based upon the atomic hydrogen maser. As a result, several improvements have been made in the performance characteristics, while the design simplicity, maintenance free life, and other features have been enhanced. Particular areas covered include experiments with thermal control, design of a large storage bulb/high line - maser using an all metal cavity, more efficient state selection, improved RF dissociator design, and a new digital automatic cavity tuning system which requires only a good quartz crystal as the reference oscillator. A second hydrogen maser has been required for this purpose in the past. Prototype standards are under construction which embody the features described. Author

N68-25773*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

10.6 MICRON LASER COMMUNICATIONS SYSTEM EXPERIMENT FOR ATS-F AND ATS-G

Nelson McAvoy, Herbert L. Richard, John H. McElroy and William E. Richards May 1968 72 p refs

(NASA-TM-X-63233; X-524-68-206) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The purpose of the coherent laser satellite-to-satellite experiment proposed for the ATS-F and -G program is to use the present laser state-of-the-art to establish the feasibility and value of optical space communications. Identical 23-pound tranceivers will be placed on ATS-F and -G, each consuming 20 watts of prime power. Information will be imposed on a frequency-modulated 10.6-micron carbon-dioxide laser beam within a 30-MHz bandwidth. A superheterodyne receiver with a 12.6-db noise figure will be used at each end of the link. A 5-inch-aperture optical antenna with a 100-db antenna gain and a 400-mw carrier, will provide a 28-db signal-to-noise ratio. The experiment, incorporating components and subsystems tested in the laboratory and field, will be the first complete laser space-communications link. By establishing the above-mentioned weight, power levels, signal-to-noise ratio, and bandwidth, and by testing its performance in actual space operation, the engineering parameters necessary to meet NASA requirements for future applications to deep-space distances or for earth-orbital missions with information capacity far greater than the 30 MHz proposed here can be realistically predicted. A single 5-inch viewing port through the skin of the 30-foot antenna, used for both transmitting and receiving, will not interfere with the structure of the antenna pattern. Optical auto-tracking, sufficiently accurate to benefit from the intrinsic high gain of the optical antenna, will supplement pointing of the optical axis with respect to the ATS geostabilization. Author

N68-25762*# Naval Academy, Annapolis, Md.

A STUDY OF THE FREQUENCY AND STABILITY CHARACTERISTICS OF A CO_2 LASER

B. J. Graham *In* NASA. Goddard Space Flight Center. The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1968 p 63–76 refs (See N68-25779 15-07)

As deep space communication applications require that the CO_2 laser be stable with respect to power and frequency, laser outputs were analyzed to determine design parameters. The lasers were dc or RF excited, and laser action was from either the P- or R-branch rotational transitions of the 00°1 to 10°0 vibrational bands of CO_2. Spectra taken of lasers with sealed windows showed spectral lines separated by as much as 36 cm^{-1} on some runs. It was determined that the fluctuations of input power, tube pressure, and thermal effects contributed to the instabilities. Shorter lasers with external isolated windows showed greatly improved frequency stability. Although as many as four transitions were observed at once, all transitions were tightly grouped with the spread between lines never greater than 2 cm^{-1}. An experimental setup is described in which a cavity resonator was used in the infrared wavelength region. It was concluded that design efforts on short lasers with external isolated mirrors were successful in producing a more monochromatic source. M.G.J.

N68-25901*# Hewlett-Packard, Co., Beverly, Mass. Frequency and Time Div.-East.

ATOMIC HYDROGEN MASER FOR SPACE VEHICLE APPLICATION, PHASE 1 Final Report, 1 Mar. 1966–31 Mar. 1968

R. F. C. Vessot and M. W. Levine Apr. 1968 58 p refs

(Contract NASw-1337)

(NASA-CR-94937) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Design and development work performed for a hydrogen maser to be mounted on an orbiting spacecraft centered on the successful operation of a breadboard prototype electronic system for both tuning the maser and providing output signals. Theoretical analysis of a Doppler canceling telemetry system has been made that includes the effects of second order Doppler shift and gravitational shift. The output information from this system is a direct measurement of the second order Doppler and the gravitational frequency shift. G.G.

N68-26016# Centro di Studio per la Fisica Delle Microonde, Florence (Italy).

RESEARCH ON CERAMIC DISCHARGE TUBES FOR GAS LASERS. 1. CONSTRUCTION OF A CERAMIC LASER TUBE. APPLICATION TO SINGLE-MODE HE-NE LASERS

M. Nasini, R. Pratesi, and G. Redaelli Oct. 1967 41 p refs

(CM-R79-8.7) CFSTI: HC $3.00/MF $0.65

The mechanical, textural, thermal, and electrical parameters for evaluating ceramics are defined, and details are given on the construction of a ceramic plasma container which can be used for

short single-mode lasers and for medium-power ion lasers. The material chosen was an Al_2O_3 ceramic with large contents of crystallized alumina embedded in a continuous glassy phase, originating from the fused impurities; this ensures the properties of vacuum tightness. The linear coefficient of thermal expansion was measured for several tube samples in order to accurately choose the type of glass for the glass–ceramic seal. The suitability of dc and RF excitation methods are discussed, and several methods for sealing the Brewster angle windows to the discharge tube are assessed. The construction of a small, compact laser tube for single-mode operation is described, and preliminary data on its performance with a 5:1 He–Ne mixture are presented. Single transverse and longitudinal mode operation was achieved on the 6328 Å transition using a spherical mirror of 130 mm radius of curvature, placed in confocal geometry. M.G.J.

N68-26324 Cornell Univ., Ithaca, N. Y.
LASER-INDUCED LUMINESCENCE AND PHOTOCONDUCTIVITY IN THE SILVER HALIDES
Robert Benjamin Laibowitz (Ph.D. Thesis) 1967 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-6427

Luminescence and photoconductivity in AgCl and AgBr were induced by Q-switched ruby laser light at low temperature. In zone-refined and Cu doped AgCl, the luminescence varies as the square of the laser intensity as a result of two-photon band to band excitation. The photocurrent in both the pure and the doped samples is a one photon effect attributed to ionization of donors. In AgBr one photon processes dominate both the luminescence and the photocurrent. The luminescence pulse in the pure material has a decay time of about 26 μsec at 7°K. At higher temperature long non-exponential tails are observed. The photocurrent pulse follows the Q-switched laser burst closely at 7°K and generally developes a tail of about 0.5 μsec at higher temperatures. The temperature dependence in the pure material indicates that the recombination center can be represented as an electron trap, 0.05 eV below the conduction band. The spectral dependence of the luminescence at low temperatures is basically identical to that observed under steady state uv excitation when the luminescence is analysed under low resolution. Dissert. Abstr.

N68-26392# Illinois Univ., Urbana. Gaseous Electronics Lab.
DYNAMICS OF OPTICAL MIXING IN A HE-NE LASER
P. A. Miller, B. E. Cherrington, and J. T. Verdeyen Wright-Patterson AFB, Ohio ARL Feb. 1968 42 p refs
(Contract AF 33(615)-5248)
(ARL-68-0033; AD-669086)

The difference frequency between two 3.39 micron signals injected into a 6328 A and/or 1.15 micron He-Ne laser has been detected as an amplitude modulation of the 6328 A and/or 1.15 micron output intensity. Experimental measurements of the bandwidth of this detection scheme have been made for a 6328 A laser detector. It is shown that the fundamental equations of laser action properly predict the behavior of the laser detector and indicate the operating conditions which are necessary in order to achieve optimum bandwidth. Author (TAB)

N68-26577# RAND Corp., Santa Monica, Calif.
OPTICAL HARMONIC GENERATION AT A METAL SURFACE
R. F. Lutomirski Mar. 1968 48 p refs
(Contract DAHC15-67-C-0141; ARPA Order 189-1)
(RM-5595-ARPA; AD-668420)

The memorandum presents a calculation of the classical interaction between laser light and a metal. Using a simple model for the statistics of the conduction electrons and their interaction with the surface, Maxwells equations and the Boltzmann equation are solved self-consistently for the fields in the metal, yielding the usual Fresnel solutions plus correction terms which, at optical frequencies and above liquid helium temperatures, are shown to be of the order of one percent. When laser light of sufficient intensity is used, a nonlinear polarization is induced and waves of twice the fundamental frequency are produced. For the indicated model and for normal incidence, the second harmonic waves in the metal are calculated and the magnitude of the relative heating is computed. The method for solving the general problem for an arbitrary incidence angle is outlined and the ratio of the average energy flux reflected in the second harmonic to the incident flux is estimated. The relevance to a high-intensity laser experiment is considered and an error in the computation of the reflection coefficient as obtained by Jha is discussed. Author (TAB)

N68-26619# Army Engineer Nuclear Cratering Group, Livermore, Calif.
AIRBORNE LIDAR OBSERVATIONS. PROJECT PRE-GONDOLA 2 Final Report
R. T. H. Collis (Stanford Res. Inst., Menlo Park, Calif.) and John Oblanas (Stanford Res. Inst., Menlo Park, Calif.) Nov. 1967 60 p refs
(PNE-1119) CFSTI: HC $3.00/MF $0.65

Lidar (laser radar) observations from an aircraft of the cloud of debris resulting from the Pre-GONDOLA II explosion at Fort Peck, Montana, are described. With the neodymium (near infrared) lidar pointing horizontally at 45° aft of the aircraft beam, the aircraft made a series of flights past the cloud position at a height of approximately 225 meters above ground level and the lidar was fired at intervals of approximately 6 seconds. Since the cloud rapidly became invisible, these flights were positioned with reference to the lidar observations using a Doppler navigation system. From the lidar observations the location, shape, and internal structure (in terms of variations of density) of the cloud at the flight level were determined at five successive times, extending some 37 minutes after the explosion and some 17 kilometers downwind. While this technique is thus shown to be immediately available (with minor improvements) for limited operational application, the developments necessary to realize its full potential are identified and described. In particular, significant improvements in the data handling system are proposed. Author (NSA)

N68-26628# Harry Diamond Labs., Washington, D. C.
AN ANALYSIS OF SINGLE MODE OPERATION OF GAS LASERS
R. T. Young, Jr. Dec. 1967 27 p refs
(HDL-TR-1369; AD-667948)

An approximate higher order theory is applied to the single mode operation of gas lasers at both low and high power levels. Three cases are worked out: (a) Uniform field, uniform excitation; (b) finite circular plane mirrors and a Bessel function radial variation of excitation; (c) Confocal mirrors. It is shown that there are two regimes of operation: output power varies with the square of the excitation rate, and output power is a linear function of the excitation rate. The quadratic type of operation occurs either for low power, or small ratio of atomic linewidth to Doppler bandwidth; the linear type for either high power or large ratio of linewidth to Doppler bandwidth. Two representative cases, a He-Ne laser and an Ar+ laser, are treated, and the results are compared with experimental data. Author (TAB)

N68-26648# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
A STUDY OF A CONTINUOUS-WAVE VOLTAGE-TUNABLE OPTICAL PARAMETRIC OSCILLATOR
Edwin G. Chaffee and Richard W. Grow Apr. 1968 143 p refs
Sponsored in part by Kistler Glass Fund
(Grants NSF GK-29; NSF GK-1644)
(UTEC-MD-035; NSF-16)

The design of a continuous-wave voltage-tunable optical parametric oscillator is considered. Two crystals of potassium dihydrogen phosphate (KH_2PO_4) are used in the system, one which doubles the frequency of an argon laser to provide an ultraviolet

pump frequency, and the other which is used as the nonlinear element in a parametric oscillator. The threshold power for the oscillator is calculated for an arrangement in which the oscillator cavity is situated inside the pump cavity. For the parameters chosen the pump cavity output power must be 1 watt to achieve threshold oscillations. The effect of simultaneously resonating the fundamental and second harmonic waves within separate cavities shows that enhancements of harmonic power of 10^6 times over that for a single pass may be possible. The frequency of oscillation is controlled by a uniform electric field applied along the c axis of the oscillator crystal. If the crystal is cooled to near its Curie temperature (122°K), the device should be tunable from 4500 Å to 6500 Å within acceptable voltage levels. Author

N68-26791# Sandia Corp., Livermore, Calif.
FAST-RISE PULSED SOLID-STATE INJECTION LASER SYSTEM
J. W. Stull and R. L. Miller Apr. 1968 28 p refs
(Contract AT(29-1)-789)
(SCL-DR-68-11) CFSTI: HC $3.00/MF $0.65

A pulsed, laser system is described for producing fast-rise, intense, coherent light pulses at 9000 Angstroms. This light is suitable for testing silicon photo devices or any other photo device with an S1-type of response. Author (NSA)

N68-26825# Sandia Corp., Albuquerque, N. Mex.
LASER GENERATED PRESSURE WAVES
N. C. Anderholm Mar. 1968 3 p Presented at the Meeting of the Am. Phys. Soc., Berkeley, Calif.
(Contract AT(29-1)-789)
(SC-DC-67-3217; CONF-680310-1) CFSTI: HC $3.00/MF $0.65

The problems associated with plasma production by laser-beam interactions with metallic surfaces are investigated. The investigation attempts to see if the problems such as expansion and turbulence could be reduced significantly by using the inertial properties of a transparent mass to clamp the plasma. NSA

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N68-25674# College of Aeronautics, Cranfield (England). Dept. of Materials.
SOME ASPECTS OF ANISOTROPIC PLASTICITY IN SHEET METALS
Roger Pearce Mar. 1968 19 p refs
(CoA-Note-Mat-15) CFSTI: HC $3.00/MF $0.65

The prediction of the yielding and flow behaviour of materials under complex stress systems from tensile test or other easily determined data has been the aim of engineers for many years. The yield criteria of Tresca and then Mises for isotropic metals are useful, but the realisation that anisotropy is the rule rather than the exception, especially in sheet metals led to the examination of Hill's anisotropic theory by various workers. In the present paper the stress-strain curves of various sheet metals are determined in uniaxial and balanced biaxial tension. As far as yielding behaviour is concerned it is concluded that the theory is reasonably satisfactory for materials where anisotropy is described with $r > 1$, with certain anomalies for materials with $r < 1$. As far as flow behaviour is concerned, the theory only applies for materials for $r > 1$. Crossing of the uniaxial and biaxial curves is observed for certain metals at low strains and this is not predicted by the theory. More work is necessary on low-r materials to resolve these matters. Author

N68-25707*# Rice Univ., Houston, Tex. Dept. of Materials Science.
RELAXATIONAL DISLOCATION DAMPING DUE TO DISLOCATION-DISLOCATION INTERSECTIONS WITH APPLICATION TO MAGNESIUM SINGLE CRYSTALS
John M. Roberts [1967] 35 p refs Presented at the Intern. Conf. on the Strength of Metals and Alloys, Tokyo, 4–8 Sep. 1967
(Grant NsG-6-59)
(NASA-CR-87745) CFSTI: HC $3.00/MF $0.65 CSCL 20B

Further experimental work concerning the modulus defect at almost zero stress for both 99.96% pure magnesium crystals and crystals doped with small amounts of Al, Zn, Cd, Th and In was carried out at 293°K. Results consistently show a static isothermal moduls defect of ≈5% at almost zero stress even for impure crystals. This suggests that the dislocations are bowing between their nodal points from almost zero stress. As a result of this it is more likely a dislocation–dislocation intersection mechanism is the source of the damping and not a dislocation-solute atom interaction mechanism as previously reported by Roberts and Hartman. A brief outline of Alefeld's theory for relaxational, amplitude dependent dislocation damping due to dislocation intersections is presented. Details concerning how the previously cited experimental data can be treated to be applicable to this theory are presented. Author

N68-25722*# Solar, San Diego, Calif.
SLURRY APPLIED DUPLEX COATINGS FOR TANTALUM AND COLUMBIUM ALLOYS
A. R. Stetson and R. T. Wimber [1967] 38 p refs Presented at the 13th Meeting of the Refractory Composites Working Group, Seattle, 18–20 Jul. 1967
(Contract NAS3-7276)
(NASA-CR-87765; RDR-1471) CFSTI: HC $3.00/MF $0.65 CSCL 11F

A duplex silicide coating process is described in which a modifier alloy is slurry applied and vacuum sintered onto the substrate preparatory to pack siliciding. Data are presented on the ability of the coatings to protect tantalum and columbium alloys from oxidation in the temperature range of 1600 to 3600°F. The data indicate protective lives of the coatings on the T222 tantalum alloy in excess of 600 hours at 1600 and 2400°F, in excess of 20 hours at 3100°F, up to 8.5 hours at 3500°F and up to 1.75 hours at 3600°F. Columbium alloys are afforded in excess of 570 hours of protection at 1600°F and in excess of 220 hours at 2400°F under a variety of test conditions. After both ballistic and falling ball impacting at R.T. and 2200°F, the coatings are protective for 1 to more than 16 hours in the temperature range of 1600 to 2400°F. Basically, the compositions are W and/or Mo silicide modified with titanium and/or vanadium. The three most promising compositions are $(35Mo–35W–15Ti–15V)Si_2$, $(95W–5Ti)Si_2$, and $(95Mo–5Ti)Si_2$. Author

N68-25730*# Kaiser Aluminum and Chemical Corp., Spokane, Wash. Dept. of Metallurgical Research.
DEVELOPMENT OF A RAPID STRESS-CORROSION TEST FOR ALUMINUM ALLOYS Final Summary Report, 1 Mar. 1966–1 Mar. 1968
W. J. Helfrich 15 May 1968 91 p refs
(Contract NAS8-20285)
(NASA-CR-61838) CFSTI: HC $3.00/MF $0.65 CSCL 11F

A new accelerated laboratory test was developed for characterizing the stress-corrosion performance of aluminum alloys 2024, 2014, 2219, 7075, 7079 and 7039. This test is based on

continuous immersion of chemically etched and stressed C-ring or tensile round specimens in a 1% NaCl–2% $K_2Cr_2O_7$ solution at pH = 4 and 60°C. The salt-(di)chromate solution (SDS) test can be completed in one week, after which a simple visual or low-power microscopic examination of the specimen surface will reveal whether cracking did or did not occur. The applicability and limitations of the developed test were demonstrated through correlation with exposures in marine and industrial environments and by alternate immersion in 3.5% NaCl solution. The SDS test promoted short-transverse failures in susceptible tempers of 2024, 2014 and 2219 at essentially the same stress levels as those which caused failure in outdoor environments or 3.5% NaCl alternate immersion. The SDS test also offered some improvement over the 3.5% NaCl alternate immersion test in promoting low stress-level failures of alloy 7039, but not at the lowest stresses which caused failure in either the marine or industrial environments. Alloys 7075-T651 and 7079-T651 behaved similarly. This was more than compensated for by the speed, non-corrosiveness, and simplicity associated with the SDS test. Author

N68-25750# Bureau of Mines, Minneapolis, Minn. Metallurgy Research Center.
RARE-EARTH SILICIDE ADDITIONS TO AN ALLOY STEEL TO INCREASE TOUGHNESS AND DUCTILITY
H. A. Tucker, R. T. Coulehan, and W. G. Wilson Jun. 1968 35 p refs
(BM-RI-7153)

An investigation was conducted to determine the appropriate quantities of rare-earth metals (REM) in the form of silicides to add to an alloy steel for the purpose of increasing toughness and ductility. The work was conducted in a vacuum induction furnace with the rare-earth additions required to deoxidize and desulfurize a simulated basic oxygen furnace (BOF) vacuum-degassed steel initially containing 0.013 to 0.016 percent sulfur. The product proved to be as good or better than the best basic electric furnace steel of the same composition made by the steel industry. Twenty-three experimental heats of 5 Ni–Cr–Mo–V steel were made, cast into 50-lb ingots, and hot-worked in a press and a rolling mill to 1/2-inch plates which were then heat-treated to 130/150 ksi^4 yield strength. Impact and tension tests showed that the addition of 0.025 to 0.100 percent, or 1/2 to 2 lb per ton, respectively, of rare-earth metals when compounded with silicon were appropriate for increasing toughness and ductility. Author

N68-25815# European Atomic Energy Community, Brussels (Belgium).
THE EFFECT OF SURFACE TREATMENT ON THE CORROSION RESISTANCE OF STAINLESS STEELS [INFLUENCE DES TRAITEMENTS DE SURFACE SUR LA RESISTANCE A LA CORROSION DES ACIERS INOXYDABLES]
Ph. Berge Apr. 1968 143 p refs In FRENCH; ENGLISH summary
(EURAEC-1972; EUR-3776.F) CFSTI: $3.00

The definition of a surface state must take into account the microgeometrical, structural, and chemical characteristics of the surface. The microgeometrical characteristics can be ascertained by numerous mechanical, optical, and pneumatic methods. Structural characteristics can be determined by optical microscopy on perpendicular and oblique sections. The surface cold-working can also be determined by X ray diffraction. An electrochemical method, which permits a comparison between the thickness and the permeability of the films responsible for passivity of the metal is suggested. It is shown how these characteristics influence the corrosion of stainless steels in different media. Efforts are directed at pitting corrosion in solutions of ferric chloride or sodium chloride, corrosion in sulphuric acid, and intergranular corrosion, either in the standard cupric sulphate reagent or in a solution of nitric acid containing hexavalent chromium. The role of the surface treatment on the oxidation of stainless steels in water and steam is discussed, which accounts for a large number of the phenomena observed. Author

N68-25885 California Inst. of Tech., Pasadena.
THE MOBILITY OF EDGE DISLOCATIONS IN THE BASAL SLIP SYSTEM OF ZINC
David Peter Pope (Ph.D. Thesis) 1967 55 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8459

This thesis presents the results of measurements of the velocities of edge dislocations in the basal slip system of zinc as a function of applied shear stress. All tests were conducted at room temperature on 99.999 percent purity zinc monocrystals. Dislocations were revealed by means of the Berg–Barrett X-ray technique. Stress pulses of microsecond duration were applied to the test specimens by means of a torsion testing machine. Applied resolved shear stresses ranged from 0 to 17.2×10^6 $dynes/cm^2$ and measured dislocation velocities ranged from 40 to 700 cm/sec. The results of this study indicate that the velocity of edge dislocations in the basal slip system of zinc is linearly proportional to the applied resolved shear stress. These results are analyzed in terms of the phonon drag theory. Agreement between this theory and the results reported in this thesis is quite good. Further work is suggested that will provide a more definitive test of the phonon drag theory for limiting dislocation motion in metallic crystals. Dissert. Abstr.

N68-25905 Iowa State Univ. of Science and Technology, Ames.
THE EFFECT OF CARBON ON THE STRENGTH OF THORIUM
Robert Lee Skaggs (Ph.D. Thesis) 1967 95 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-8934

The flow stress of thorium carbon alloys containing from 0.008 to 2.83 atom percent carbon was measured over the temperature range from 4.2°K to 573°K. Constant strain rate and constant stress measurements of flow stress were made at rates of deformation from 4×10^{-12} to 1.3×10^{-2} per second. The flow stress was found to be composed of a thermally activated component and an athermal component. The thermally activated component increases linearly with carbon content and with the logarithm of the strain rate. The athermal component is a function of carbon content and of strain. The strengthening of thorium was due to a strong interaction between randomly distributed carbon atoms and moving dislocations. A yield point was observed which was a maximum at 250°K. The size of the yield point increased with decreasing grain size, slow cooling from recrystallization temperature, and increasing carbon content. Dissert. Abstr.

N68-25906 Utah Univ., Salt Lake City.
DISLOCATION DYNAMICS IN NICKEL SINGLE CRYSTALS
Richard Whitney Rohde (Ph.D. Thesis) 1967 163 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-8490

The velocities of edge dislocations moving in nickel single crystals were measured as a function of stress at temperatures between 77°K and 273°K. The activated volume, associated with the size of a dislocation excited over an energy barrier, varied linearly with temperature. The increase in volume was attributed to dislocation widening with temperature and to increasing the length of dislocation line activated over the pinning site as the temperature increased. The activation enthalpy for dislocation motion was found to be independent of stress. The activation energy necessary for operation of the dislocation sources was found to be 1000 cal/mole. Yield point measurements of pure and doped nickel showed that doping affected the activation energy for dislocation motion. An attempt was made to verify the validity of stress relaxation tests for use in finding the stress dependence of velocity. Dissert. Abstr.

N68-25926# TRW Systems, Redondo Beach, Calif.
STUDY OF THE CHEMICAL INTEGRITY OF RADIOISOTOPE CONTAINMENT MATERIALS IN LAUNCH ABORT ENVIRONMENTS
W. Gregson, Jr. Dec. 1967 111 p refs Prepared for Sandia Corp.
(SC-CR-67-2830) CFSTI: HC $3.00/MF $0.65

Three representative radioisotope containment materials (316 stainless steel, Haynes 25, and tantalum) were tested in controlled flame environments along with other materials to determine the degree of hazard to be expected from the hostile environment from an on-pad abort. Qualitative and quantitative results are presented and include gross damage to the materials and metallurgical degradation from chemical interaction.

Author (NSA)

N68-25956# Technische Hochschule Munchen (West Germany).
THE FATIGUE BEHAVIOR OF NICKEL AND NIMONIC 80 A UNDER MECHANICAL TENSILE STRESS LOAD AND TIME CONSTANTS OR VARYING TEMPERATURES [DAS FORMAENDERUNGSVERHALTEN VON NICKEL UND NIMONIC 80 A UNTER MECHANISCHER ZUSPANNUNGS-BEANSPRUCHUNG UND ZEITLICH KONSTANTEN ODER VERAENDERLICHEN TEMPERATUREN]
Hans Riege (Ph.D. Thesis) 1967 166 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Creep studies were made with 3-mm wire samples of pure nickel and Nimonic 80A at constant and variable temperatures in the range from 350° to 870°C and under constant tensile loads. While the deformation behavior of nickel at constant as well as variable temperatures can be described by the same creep law, the creep velocity and crack initiation of Nimonic 80 A are clearly accelerated under variable temperature stress. The deformation mechanisms are discussed on the basis of physical creep theories, and the accelerated deformation of Nimonic 80 A is ascribed to microscopic temperature stresses at the precipitating particles. Optical- and electron-microscopic studies were performed of the microstructure, and samples were measured for damping, hardness, elasticity, and electrical conductivity. The differences between thermal expansion matrix coefficients and precipitations in Nimonic 80 A were estimated. The experimental results in combination with the creep theory for precipitation-hardened alloys are used to propose a modified creep law for approximating the behavior of Nimonic 80 A under any given temperature conditions.

Transl. by K.W.

N68-25961# Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center.
TITANIUM FOR THE CHEMICAL ENGINEER
1 Apr. 1968 63 p refs Presented at Am. Inst. of Chem. Engr. 1st Mater. Eng. and Sci. Conf., Philadelphia, 31 Mar.–4 Apr. 1968
(Contract F33615-68-C-1325)
(DMIC-MEMO-234; AD-667534)

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N68-25962# Crucible Steel Co. of America, Midland, Pa.
BASIC METALLURGY OF TITANIUM
Howard T. Clark and J. A. Manfre *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 1–7 ref (See N68-25961 15-17)

Metallurgy of titanium and titanium alloys is discussed in an overview paper that summarizes physical, mechanical, and other properties. Mention is made of the commercial pure grades, alpha, alpha–beta, and beta type alloys that are presently on the market; and properties of such alloys and their applications are tabulated. General performance capabilities are outlined for the unalloyed titanium and the three types of alloys; and annealing and heat treatment processes are discussed for them. M.W.R.

N68-25963# Bureau of Mines, Washington, D. C.
THE PRODUCTION OF PRIMARY TITANIUM METAL
Kenneth B. Higbie and John W. Stamper *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 8–12 refs (See N68-25961 15-17)

Ilmenite and rutile are discussed as the two most important sources of titanium in the United States, and mention is made of mining and mineral processing. Metal production technology is described; and reduction of titanium tetrachloride by magnesium, sodium, and electrolytic processes is detailed. Metallic reduction of titanium dioxide and metal consolidation are also considered. It is noted that with improved technology, titanium costs have gone down; and that in-process technology may result in further reduction in metal production costs. M.W.R.

N68-25967# Reactive Metals, Inc., Niles, Ohio. Research and Development Div.
THE GENERAL CORROSION RESISTANCE OF TITANIUM
H. B. Bomberger *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 29–34 refs (See N68-25961 15-17)

Salt, oxidizing, and nonoxidizing environments are considered in a review of the corrosion resistance of titanium that also discusses guidelines for selecting titanium for specific applications. Typical corrosion rates are given for commercially pure titanium in various salt solutions, mineral acids, and organic acids. Unalloyed titanium displays good resistance to most aqueous chemicals of a neutral or oxidizing nature; and the metal can be attacked by ionizable fluoride compounds, anhydrous strong oxidizers, and uninhibited reducing acid solutions. Effect of alloying on the corrosion behavior of titanium is also discussed; and it is noted that corrosion resistance can be improved greatly by alloying, use of inhibitors, and application of a small anodic current. M.W.R.

N68-25968# Battelle Memorial Inst., Columbus, Ohio.
STRESS-CORROSION CRACKING OF TITANIUM AND ITS ALLOYS
W. K. Boyd *In its* Titanium for the Chem. Engr. 1 Apr. 1968 p 35–44 refs (See N68-25961 15-17)

Environments associated with the stress corrosion cracking of commercial titanium and titanium alloys are discussed, and some observations are made on hot salt cracking and the resistance of certain titanium alloys. Effect of temperature, stress, and time exposure on cracking is reviewed; and it is noted that stress corrosion in titanium has not been observed at temperatures below about 500°F, with the greatest susceptibility between 550° and 800°F. At temperatures of 800°, 900°, and 1000°F, depending on the alloy, general corrosion is so rapid that stress corrosion cracking is masked. Roles of oxygen, water, hydrogen, and chlorine in cracking are discussed; and observations are made of stress corrosion cracking in nitrogen tetroxide and methanol. In each case cracking mechanisms are proposed. Accelerated crack propagation in titanium alloys exposed to sea water is discussed, and data are tabulated for a wide variety of titanium alloys. Attention is then given to the relationship between composition, heat treatment, microstructure, and susceptibility to cracking. Liquid-metal embrittlement is also considered. M.W.R.

N68-25969# Naval Ship Research and Development Center, Annapolis, Md.

ACCELERATED CRACK PROPAGATION IN LIQUID ENVIRONMENTS

I. Roy Lane *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 45–49 refs (See N68-25961 15-17)

Behavior characteristics and influence of metallurgical structure are discussed in relation to low stress level crack propagation that can occur when titanium alloys are used in chemical environments. Nature of the alloy is considered along with structural design, stresses, and the actual liquid environment. While the metallurgist can predict with a fair degree of accuracy the behavior of a particular alloy based on its composition and thermal history, the only positive method for determining susceptibility to crack propagation is to test the heat of the alloy via the notched cantilever-beam stress corrosion test. M.W.R.

N68-25970# Wyandotte Chemicals Corp., Mich. Materials Engineering Section.

PERFORMANCE OF TITANIUM IN THE CHEMICAL INDUSTRY

L. W. Gleekman *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 50–56 refs (See N68-25961 15-17)

Recent experiences of titanium and titanium alloys in the chemical industry are related, including that involving heat exchangers and vessels such as absorbers and columns. This overview deals with experiences of government, research laboratories, titanium producers, and major users; and is particularly concerned with the resistance of titanium to crevice corrosion. The palladium alloy of titanium, a platinum or palladium electrodeposit on titanium, and anodized titanium have been used to overcome this corrosion. M.W.R.

N68-25971# Harvey Aluminum, Torrance, Calif.

THE HISTORY OF TITANIUM IN THE HARVEY ALUMINUM ST. CROIX DESALINATION PLANT

G. A. Moudry *In* Battelle Mem. Inst. Titanium for the Chem. Engr. 1 Apr. 1968 p 57–60 refs (See N68-25961 15-17)

The seamless titanium tubing in a production multiple stage flash evaporator used in a desalination plant is found to be almost completely resistant to corrosion in sea water environments, including those found in and around brackish inlets and industrial areas. The titanium is extremely resistant to velocity-cavitation attack and erosion; and the efficiency of the heat exchanger is increased because greater velocities can be used. This increased velocity also decreases marine fouling. Cold finished seamless titanium tubing has a greater yield strength than other materials, even though it is about one-half the weight. While the titanium tubing is high in price, it reduces overall production costs. M.W.R.

N68-26054 Arizona Univ., Tucson.

THERMALLY-ACTIVATED SERRATED YIELDING IN SELECTED ALUMINUM ALLOYS

Roger Bristol Clough (Ph.D. Thesis) 1967 191 p

Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-8808

A study has been made of the phenomenon of serrated yielding in selected aluminum alloys. The method of study of the phenomenon was by (a) tensile tests to determine the strain to onset of serrated yielding and the yield stress as a function of temperature and strain rate and by (b) the development and use of stress relaxation after plastic deformation to determine the dislocation mechanisms governing plastic flow in the serrated yielding range. An experimental method to determine the activation energy for plastic flow in stress relaxation was developed which shows good agreement with other methods. In addition, other experimental possibilities for the method are pointed out. A dislocation model was developed to explain the temperature and strain rate dependence of the strain to onset a serrated yielding in the region where Cottrell-type strain-aging models fail to explain the phenomenon. Dissert. Abstr.

N68-26061*# Hercules Powder Co., Wilmington, Del. Research Center.

A STUDY OF THE MECHANISM OF CHEMICAL REACTIVITY OF NITROGEN TETROXIDE WITH TITANIUM ALLOYS Quarterly Report, 1 Jan.–31 Mar. 1968

15 Apr. 1968 46 p refs

(Contract NAS8-21207)

(NASA-CR-61824; HRC-68-1; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The development of a satisfactory stress corrosion cracking (SCC) test for 6 A1 4V ELI titanium alloy exposed to liquid nitrogen tetroxide at 165°F, was successfully completed. The majority of the work was aimed at clarifying the roles of dissolved oxygen and N_2O_3 in the creation and inhibition of SCC. On the basis of this work, oxygen appears to be involved in the crack initiation and propagation mechanism. It was also shown that as little as 500 ppm. NO added to N_2O_4 will prevent SCC. The critical level may be significantly lower. Additional work was done to assess the possible role of nitrous acid as a corrosion inhibitor but the results were not definitive. Data are presented concerning the effect of NO content on normal corrosion rates, the solubilities of various metals in liquid N_2O_4 and possible compositions of Red Non-Reactive N_2O_4. A satisfactory method for the production of small amounts of dry, NO-free N_2O_4 was devised and is in the process of scale-up in preparation for a series of critical add-back experiments involving H_2O, NO, and 100% HNO_3. Author

N68-26156*# IIT Research Inst., Chicago, Ill.

CURRENT ACTIVITIES AT IITRI ON HIGH-TEMPERATURE PROTECTIVE COATINGS

V. L. Hill, A. L. Hess, and M. J. Malatesta [1967] 17 p refs Presented at the 13th Refractory Composites Working Group Meeting, Seattle, 18–20 Jul. 1967

(Contract NAS7-431)

(NASA-CR-89349) CFSTI: HC $3.00/MF $0.65 CSCL 11F

New developments directed toward the use of refractory materials in liquid fueled rocket engines are discussed. Two areas of investigation are summarized: (1) development of iridium coatings on tungsten and tantalum, and (2) corrosion rates of refractory materials in flowing fluorine environments. The use of a slurry coating technique, in which a metallic vehicle is employed to provide sintering of the coating, displayed the following advantages over other techniques: no basic size limitations, maximum utilization of iridium, ease of application, and ease of recovery of iridium from excess slurry. Fluorine corrosion tests were conducted on selected structural materials with different protective coatings to determine their corrosion resistance under variable flow conditions. Test

results are summarized and plotted. Data obtained from these experiments indicate the potential of using iridium coatings for both oxygen and fluorine containing environments. A.L.

N68-26163 California Univ., Berkeley.
DYNAMIC BEHAVIOR OF ALUMINUM CRYSTALS
Ashok Kumar (Ph.D. Thesis) 1966 56 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8594

The dislocation drag coefficient of aluminum single crystals was measured by the strain rate method at 10°K, 77°K, 300°K and 500°K. A maximum shear strain rate of 2.6×10^{4}/sec. was obtained by the Kolsky thin wafer technique in pure shear. The back stress was attributed to the overcoming of internal stresses associated with forest dislocations. The temperature dependence and the effect of strain on the drag coefficient are discussed in terms of the dislocation-phonon damping theories. The possibility of a new dislocation–dislocation damping mechanism is explored. Dissert. Abstr.

N68-26168 Iowa State Univ. of Science and Technology, Ames.
FATIGUE OF 2024-T3 ALUMINUM ALLOY DUE TO BROAD-BAND AND NARROW-BAND RANDOM LOADING
Benny Max Hillberry (Ph.D. Thesis) 1967 85 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8913

Broad-band and narrow-band fatigue tests were conducted on small cantilever specimens of 2024-T3 aluminum alloy. The end of the specimen was connected through a pinned connection to the moving coil of an electrodynamic shaker. A random-noise generator was used as the input to the system. Selecting the proper resistance for the moving coil eliminated the resonant behavior of the shaker and provided a flat frequency response of the system from 0 to 220 cycles per second. For the broad-band tests, the output from the random-noise generator was filtered with a band-pass filter which was flat within 2db between 20 and 220 cycles per second. This is apparently the widest power spectrum that has been used for random fatigue tests in which the specimen is loaded directly. A very narrow-pass filter was used for the narrow-band tests. The ratio of the number of zero crossings with positive slope per second to the number of positive peaks per second was 0.788 for the broad-band loading and 1.0 for the narrow-band loading. Dissert. Abstr.

N68-26196*# Hercules Powder Co., Wilmington, Del. Research Center.
A STUDY OF THE MECHANISM OF CHEMICAL REACTIVITY OF NITROGEN TETROXIDE WITH TITANIUM ALLOYS Quarterly Report, 1 Oct.–31 Dec. 1967
Albert Z. Conner and Alan D. Craig 15 Jan. 1968 84 p refs
(Contract NAS8-21207)
(NASA-CR-61823; HRC-67-3; QR-2) CFSTI: HC $3.00/MF $0.65
CSCL 11F

The development of a standard corrosion test procedure is essentially complete. In recent tests, 30 out of 30 U-bend specimens of 6 Al–4V titanium alloy cracked during exposure to Red Reactive (RR) N_2O_4, while no cracking was observed in 10 U-bend specimens exposed to Green 8 (0.8% NO) N_2O_4 under identical conditions. These results were obtained in four separate tests utilizing 10 specimens each and were carried out at 167°F, for a maximum of 72 hours. Twenty specimens formed with a radius 5 times the thickness broke in half after exposure to RR N_2O_4 at a stress level of about 90% of the transverse or longitudinal yield strength. Another group of 5 pairs of specimens exposed to RR N_2O_4 at stress levels of 30, 50, 70, 90 and 100+% of the longitudinal yield strength also cracked in less than 72 hours. A group of 10 specimens stressed to about 90% of the longitudinal yield strength and exposed to G8 N_2O_4 for 72 hours at 167°F, showed no evidence of cracking. Author

N68-26205 Utah Univ., Salt Lake City.
A KINETIC STUDY OF THE CEMENTATION OF COPPER WITH IRON
Ravindra Mohan Nadkarni (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8826

The kinetics of cementation of copper with iron were observed to follow first order kinetics and to increase with the speed of agitation to a limiting value. The experimental activation enthalpy was 5.06±0.71 kilocalories per mole. The observed maximum rates agree closely with theoretical values based upon a model of aqueous solution diffusion through a diffusion boundary film of limiting thickness. Furthermore, the rate determining step was found to be the diffusion of a water molecule out of the path of hydrated cupric ions as the latter diffused towards the iron surface. Back reaction kinetics are shown both theoretically and experimentally to be independent of ferrous ion concentration in solution. Dissert. Abstr.

N68-26238# Tokyo Univ. (Japan). Inst. of Industrial Science.
STUDIES ON THE FLOW STRESS OF METALS AND ALLOYS
Hiromu Suzuki, Shin Hashizume, Yutaka Yabuki, Yukinori Ichihara, Satoshi Nakajima et al Mar. 1968 97 p refs /*ts* Vol. 18, No. 3, Serial No. 117
CFSTI: HC $3.00/MF $0.65

Compression type of high temperature, high speed testing machines for flow stress measurements of metals and alloys are described. The technical aspects of using the machines are discussed in relation to methods for maintaining a constant strain rate, and measuring load and strain in a high speed experiment. The flow stress of aluminum, duralium, zinc, magnesium, titanium and copper alloys was obtained in the strain rate range of 0.1–650 sec^{-1} and in the temperature range of 75° to 900°. The flow stress of high strength, low alloy, carbon and stainless steels is also considered. Data sheets are given in the form of flow stress-strain curves. B.S.D.

N68-26261# Compagnie des Ateliers et Forges de la Loire, Paris (France). Centre de Recherches.
STUDY OF STRESS CORROSION AND OF GENERAL CORROSION OF STAINLESS STEELS IN DILUTE SOLUTIONS OF CHLORIDES AT 350°C TO 360°C AND IN STEAM AT 500°C. EVOLUTION OF THE MECHANICAL PROPERTIES AND OF THE STRUCTURE AT THESE TEMPERATURES, POSSIBILITY OF MAKING USE OF PROTECTION BY SURFACE CHROMIZATION, PART 2 Final Report
P. Poyet et al Oct. 1967 71 p refs
(Contract EURATOM-033-64-9-TEEF (RD))
(EURAEC-1947, Pt. 2) CFSTI: HC $3.00/MF $0.65

Tests were performed on eight grades of stainless steels, four with an austenitic structure and four with an austeno-ferritic structure. The influence of molybdenum and/or silicon additions were studied. Silicon steels display a certain tendency to embrittlement, toward 300 to 400°C for austeno-ferritic steels and 500 to 600°C for austentic steels. The effect of silicon is stronger than that of molybdenum additions which produces also a certain embrittlement in the case of austeno-ferritic steels, toward 350 to 400°C. Silicon improves the mechanical characteristics and the resistance to creep for short times. Molybdenum improves the resistance to creep. The diminishing resistance to creep of silicon steels, over long durations, is probably due to structural transformations making it useful to study these transformations by the technique used in physical metallurgy. NSA

N68-26315# Iowa State Univ. of Science and Technology, Ames.
INCREASE IN THE CRITICAL SHEAR STRESS BY THE PRECIPITATION OF STRESSED COHERENT PARTICLES
H. Gleiter [1967] 12 p refs Transl. into ENGLISH from Z. Angew. Phys. (W. Berlin), v. 23, no. 2, 1967 p 108–111
(IS-TRANS-75) CFSTI: HC $3.00/MF $0.65

The increase in shear stress of an alloy owing to far reaching stress fields of coherent precipitates was calculated and compared with the results obtained in three earlier studies. It is assumed that besides the distribution of the precipitates only the far reaching stress fields determine the mechanical properties of the alloy. NSA

N68-26411# Naval Radiological Defense Lab., San Francisco, Calif.
ELECTROCHEMICAL CORROSION STUDIES OF GALVANICALLY COUPLED SNAP-21 MATERIALS
Donald A. Kubose and Herman I. Cordova 15 Jan. 1968 36 p refs
(USNRDL-TR-68-26; AD-668161)

Electrochemical corrosion rate measurements on materials used in the SNAP-21 radioisotopically-fueled power system have been made in seawater at room temperature. The materials examined included aluminum, copper, Hastelloy C, Hastelloy X, nickel, 3-4 stainless steel, tantalum, titanium-621 alloy and uranium-8% molybdenum alloy. The normal corrosion rate of each material was measured by means of galvanostic polarization techniques. A galvanic series of the materials in seawater was determined and the galvanic currents between galvanically coupled materials were measured with a zero-resistance ammeter circuit. The effect of galvanic coupling of construction materials of the SNAP-21 system does not materially change the containment time of the Sr-90 fuel in the corrosive seawater environment. Author (TAB)

N68-26426# Columbia Univ., New York. Henry Krumb School of Mines.
DAMPING IN DEFORMED IRON CONTAINING INTERSTITIAL IMPURITIES
Birendra Nath Agarwala 15 Mar. 1968 145 p refs
(Contract Nonr-266(61))
(TR-10; AD-668173)

The internal friction spectrum in polycrystalline iron has been studied around 1 Hz from -60 degrees C to 380 degrees C as a function of deformation, interstitial content, state of annealing, strain amplitude and the temperature at which the recrystallization is carried out prior to deformation. Plastic deformation produces two major peaks centered at 47 degrees C (peak D) and at temperature range between 220 degrees C to 290 degrees C (cold-work peak). The features of peak D are explained by a model based on enhanced Snoek relaxation, with strong harmonic generation, caused by the motion of the dislocations. In a dilute iron-carbon alloy the cold-work peak initially rises and then falls with increasing deformation. The peak temperature in the same specimen drops with increasing deformation. In the iron-carbon system Schoecks theory based on dislocation motion giving rise to the anelastic strain can explain the observed features of the cold-work peak. The rising background damping occurring at the higher temperature side near the cold-work peak is observed to be sensitive to the degree of deformation, amount of solute content and the state of annealing. Author (TAB)

N68-26433# Compagnie des Ateliers et Forges de la Loire, Paris (France). Centre de Recherches.
A STUDY ON THE STRESS CORROSION OF STAINLESS STEELS IN CHLORIDE SOLUTIONS, PART 1 Final Report
A. Desestret and G. H. Wagner Oct. 1967 122 p refs
(Contract EURATOM-033-64-9-TEEF (RD))
(EURAEC-1947, Pt. 1) CFSTI: HC $3.00/MF $0.65

Tests were performed on eight grades of stainless steel, four with an austenitic structure and four with an austeno-ferritic structure. Testing devices used for the study are described. Sample preparations are summarized. Tests in boiling concentrated solutions of magnesium chloride to 44% at 153°C, calcium chloride to 62% at 150°C, and sodium chloride (5N) at 107°C were performed. Results are given. Stress corrosion tests in chlorinated water at 150°C were carried out at various pH in low-pressure autoclaves. At 200°C, tests were performed at pH of 2.6, 6.5 and 10. Experimental data are tabulated and results discussed and compared to previous results. NSA

N68-26463# Naval Air Development Center, Johnsville, Pa.
EVALUATION AND COMPARISON OF THE CORROSION SUSCEPTIBILITIES OF 7178 ALUMINUM PLATE MATERIAL OF VARIOUS TEMPERS
John J. De Luccia and Irv S. Shaffer 16 Apr. 1968 19 p
(NADC-MA-6716; AD-668991)

Plate material of 7178 aluminum alloy in the -T651 and -T7651 tempers was evaluated for resistance to exfoliation and stress corrosion. Stress corrosion susceptibility was determined using tuning fork specimens stressed in the short transverse direction and exposed to alternate immersion in 3-1/2% NaCl solution. Susceptibility to intergranular and exfoliation corrosion was determined by exposure in both acetic acid salt spray and NaCl-SO2 environments. The -T651 temper was found to be acutely susceptible to intergranular corrosion and hence exfoliation and stress corrosion cracking. The -T7651 temper is less susceptible to intergranular attack and more resistant to exfoliation and stress corrosion cracking than the -T651 temper. Author (TAB)

N68-26554# Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.
VANADIUM CLADDING ALLOY DEVELOPMENT Quarterly Progress Report, Period Ending 31 Dec. 1967
E. C. Bishop, R. A. Nadler, and G. A. Whitlow Jan. 1968 57 p refs
(Contract AT(30-1)-3791)
(WARD-3791-13) CFSTI: HC $3.00/MF $0.65

Physics calculations have shown that the sodium void coefficient of reactivity was 8 percent more favorable for 0.010-inch-thick V–Cr–Fe–Zr–C alloy (HSV 207) than for 0.014-inch-thick Type 316 stainless steel. The Doppler coefficient of reactivity, which was nearly independent of cladding thickness was 10 percent more favorable for HSV 207 than for type 316 stainless steel. The breeding ratios were nearly the same for both vanadium alloys and type 316 stainless steel. Fuel cycle cost calculations have indicated that for a vented design, and assuming a 4 $/ft tubing cost, the most favorable vanadium alloy cladding design, 0.010-inch-thick V–Fe–Cb–Zr–C (HSV 209), was approximately 0.07 mill/kWh more expensive than the 0.014-inch-thick type 316 stainless steel. For a non-vented design, assuming a 4 $/ft tubing cost, the same design was about 0.09 mill/kWh more expensive. Plant equipment cost savings have been examined in conjunction with the possibility of raising the reactor coolant outlet temperature from 1000 to 1100°F. One 3.8-inch-diameter ingot of each of the three alloys V-20, Ti, HSV 207, and HSV 209 was produced. A rod for the irradiation evaluation program has been made by swaging part of the HSV 209 ingot. The processing of sheet from all three alloys was initiated. Mechanical property and creep data have been obtained from the small scale up of HSV 209. Construction of the two sodium corrosion loop systems, VTL-1 and VTL-2, was started. NSA

N68-26571# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
NOTE ON FATIGUE MECHANISM IN FCC METALS AT ULTRASONIC FREQUENCIES

W. P. Mason and W. A. Wood Mar. 1968 22 p refs
(Contract Nonr-266(91))
(TR-59; AD-668499)

A comparison is made of microstructural changes leading to fatigue of copper and alpha-brass at small strain-amplitudes imposed at the normal test frequency of 1700 cpm and at the ultra-sonic frequency of 1700 cps. A striking difference appears in the distribution of slip. At normal frequency the slip spreads densely over a grain, with no slip-band cracking (stage S of the S/N curve). At ultrasonic frequency the slip concentrates in single isolated bands in only occasional grains and reduces these to microcracks before any general spread of slip can be observed. However, as might be expected, the ultra-sonic slip did spread in specimens tested at elevated temperatures which expedited dislocation climb and diffusion processes; then this spreading of slip prevented the slip-band microcracking at ultra-sonic frequency also.
Author (TAB)

N68-26613# Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering.
AN INVESTIGATION OF THE COMPONENTS OF THE FLOW STRESS IN TITANIUM AND ZIRCONIUM Progress Report
R. E. Reed-Hill and V. Ramachandran 15 Feb. 1968 31 p refs
(Contract AT(40-1)-3262)
(ORO-3262-5) CFSTI: HC $3.00/MF $0.65

Tensile tests were conducted on pure titanium at 77 to 1133°K, on pure zirconium at 4 to 813°K, and on Zircaloy-2 at 77 to 900°K to determine the flow stress of these materials. The role of twinning during tensile deformation of zirconium was investigated. It was concluded that deformation twinning is of general major importance in the plastic deformation of zirconium at very low temperatures.
NSA

N68-26615# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
INHMOGENEOUS DEFORMATION EFFECT IN ZIRCALOY-4 ROLLED PLATE
J. L. Jellison, A. Nugent, and R. F. Lupi 8 Feb. 1968 20 p refs Presented at 97th Ann. AIME-TNB Meeting, New York, 29 Feb. 1968
(Contract W-31-109-ENG-52)
(KAPL-P-3406; CONF-680202-2) CFSTI: HC $3.00/MF $0.65

Hot-rolling experiments were conducted to define the causes of surface cracking in Zircaloy-4. A varied number of passes were used to achieve a reduction from 300 to 125 mils at 1460° ± 10°F. To reduce surface oxidation specimens were jacketed with mild steel which was removed mechanically after rolling. The strips were processed further by cold and warm sizing and reduced from 4% to 24% in one, five, and ten passes followed by annealing for 2-1/2 hours at 1400° ± 10°F. Texture of the strips was significantly effected by the rolling schedule. Inhomogeneous deformation was observed in strips rolled by a 20-pass schedule and surfaces had transverse corrugations. Strips rolled at 5 passes of 20% reduction exhibited no evidence of corrugations. Those rolled at 20 passes exhibited bands which appeared to contain material of different crystallographic orientation than the rest of the strip and local thinning was noticeable where the bands intercepted the surface. It is posulated that the positions at which banding occurs may depend upon localized composition differences, crystallographic differences, residual stress distribution, dislocation densities, and grain size.
NSA

N68-26622# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATION OF EFFECT OF VACUUM ON PROCESS OF CONTACT FAILURE OF STEELS [EKSPERIMENTAL'NOYE ISSLEDOVANIYE VLIYANIYA VAKUUMA NA PROTSESS KONTAKTNOGO RAZRUSHENIYA STALEY]
S. V. Pinegin and V. M. Gudchenko 23 Jun. 1967 18 p refs Transl. into ENGLISH from Mashinovedeniye (USSR), no. 1, 1965 p 119–126
(FTD-MT-67-57; AD-668926)

Investigation of properties of materials in extreme conditions is the most important problem of new technology. Study of behavior of materials with contact loading in vacuum has great practical value. Various samples of steel were tested. Two types of tests were specified. In the first case it was determined the number of cycles which the material could withstand before the appearance of catastrophic wear. In the second case testing was conducted with consecutive gradual increase of number of cycles of loading from 500 thousand to 10 million. The article gives results of the tests and conclusions regarding causes of wear, advantages of various degrees of vacuum advantages of use of various lubricants and bearings, and application of plastic films on friction surfaces.
TAB

N68-26655 Michigan Univ., Ann Arbor.
COMPREHENSIVE CAVITATION DAMAGE DATA FOR WATER AND VARIOUS LIQUID METALS INCLUDING CORRELATIONS WITH MATERIAL AND FLUID PROPERTIES
Ramon Garcia (Ph.D. Thesis) 1966 422 p
Available from Univ. Microfilms: HC $19.15/MF $5.40 Order No. 67-8254

The primary objective of this investigation is to obtain a better basic understanding of the cavitation-erosion phenomenon. This was attained in the following manner: (a) by determining the cavitation resistance of a wide variety of useful materials, which represent a large range of mechanical properties, including steels, refractory alloys, aluminum, copper, nickel, brass and plastics, in a broad range of fluids; (b) by obtaining a comprehensive correlation of the cavitation damage data with applicable material and fluid properties utilizing a suitable computer program, so that one might be able to predict a priori the behavior of a new material under a given set of fluid-temperature conditions; (c) by developing a relationship between the damage incurred in a flowing venturi device operated by this laboratory and the damage obtained in the accelerated vibratory facility studies which are the subject of this dissertation; and (d) by developing a practical high-temperature ultrasonic vibratory device for use in this investigation.
Dissert. Abstr.

N68-26718# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
ELEVATED TEMPERATURE HARDNESS TESTING OF PLUTONIUM–GALLIUM ALLOYS
D. D. Hays Mar. 1968 5 p
(Contract AT(45-1)-1830)
(BNWL-682) CFSTI: HC $3.00/MF $0.65

Equipment and procedures used to determine microhardness of Ga–Pu alloys between room temperature and 415°C are described. It was determined that the effect of creep, starting at about 325°C, significantly lowered hardness values.
NSA

N68-26730# Bettis Atomic Power Lab., Pittsburgh, Pa.
THE CORROSION AND HYDROGEN ABSORPTION CHARACTERISTICS OF ZIRCONIUM ALLOYS CONTAINING IRON AND CHROMIUM IN HIGH TEMPERATURE WATER AND STEAM
Stanley Kass Feb. 1968 61 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-517) CFSTI: HC $3.00/MF $0.65

The corrosion and hydrogen absorption properties of zirconium base alloys containing 0.5 or 1.0% iron, 0.5 or 1% chromium, and 0 or 0.5% tin in high temperature water and steam have been studied. The alloy containing 0.5% iron and 1.0% chromium with or without 0.5% tin exhibits a very low corrosion rate and at the same time very low hydrogen pickup tendencies. For applications at 680°F and below, the corrosion properties of the tin-bearing alloy are superior. For applications above 680°F, the tin-free alloy is superior. Author (NSA)

N68-26751# Ohio State Univ. Research Foundation, Columbus.
STRESS CORROSION CRACKING OF IRON–NICKEL–CHROMIUM ALLOYS
R. M. Latanision and R. W. Staehle Oct. 1967 175 p refs Presented at the Conf. on Fundamental Aspects of Stress Corrosion Cracking, Athens, Ohio, 11–15 Sep. 1967
(Contract AT(11-1)-1319)
(COO-1319-61; CONF-670963-1) CFSTI: HC $3.00/MF $0.65

Stress corrosion cracking in the Fe–Ni–Cr alloy system in aqueous media is reviewed. Special emphasis is given to austenitic alloys. Cracking of these alloys is reviewed critically as a function of metallurgical and environmental variables. The varous mechanisms of stress corrosion cracking are considered with respect to their applicability to this alloy system. Author (NSA)

N68-26797# Bettis Atomic Power Lab., Pittsburgh, Pa.
RECOVERY AND RECRYSTALLIZATION KINETICS OF COLD-WORKED ZIRCALOY-4 PLATE AND TUBING. LWBR-LSBR DEVELOPMENT PROGRAM
O. M. Katz Feb. 1968 94 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-590) CFSTI: HC $3.00/MF $0.65

Empirical kinetic equations were derived to describe the recovery region between 550 and 1020°F for times to 4000 hours for 15 to 78% cold-worked Zircaloy-4 plate and tubing. The properties studied were electrical resistivity and X-ray line sharpening. Recrystallization kinetics were described with sigmoidal curves derived from X-ray intensity and microhardness data. Light, replica, and transmission electron microscopy, and selected-area electron diffraction were used to postulate recovery and recrystallization mechanisms. From a structural aspect, the annealing process in cold-worked Zircaloy-4 is visualized as a dislocation climb and annihilation process to the limit allowed by the size of the deformation subcells, a reorientation of the subgrain material into a recrystallization texture, a growth of reoriented cells located in the most highly worked bands, and a consumption of less favorably strained and/or oriented cells by the high-angle boundaries of the reoriented cells. Comparison of 15 and 73% cold-worked tubing showed the activation energy to be less (21 versus 60 kcal/mol) and the subcell size greater (8000Å versus 1000Å) for the 15% cold-worked material. Author (NSA)

N68-26826# Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering.
STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS Technical Progress Report, 1 Mar. 1967–1 Mar. 1968
A. A. Hendricksson, B. C. Peters, and R. A. Strahl 1 Mar. 1968 30 p refs
(Contract AT(11-1)-916)
(COO-916-13; TPR-8) CFSTI: HC $3.00/MF $0.65

The compositional and temperature dependence of the critical resolved shear stress, the activation energy, and activation volume for deformation in dilute solutions of Ag–In and Ag–Sn alloys are investigated. The concentration dependence of strengthening depends on whether the solute addition is a gradual or rapid strengthener. Sn is a rapid hardener. The activation energies for deformation in Ag–In and Ag–Sn appear to be the same. The activation volume, however, is considerably smaller for the Ag–Sn case. Measurements of the activation volume have disclosed empirical relations which should be important in the theory of thermally activated glide in fcc solid solutions. The fcc metal solid solutions investigation concerns the measurement of dislocation velocity with strain rate sensitivity. The experimental work continues on techniques such as crystal growth and crystal cutting. The strength and deformation quantities for Nb–Ta and Nb–Mo solid solutions are investigated at high ≈300 and 4.2°K. The modulus interaction does not make an important athermal strengthening contribution in Nb based alloys; solute hardening appears to be due to an atomic size interaction. Thermally activated glide in Nb and Nb–Ta alloys follows the Peierls barrier mode. In Nb–Mo alloys considerable deviation is found. For testing at 4.2°K (in compression), Nb, Nb–Ta and Nb–Mo alloys show deformation twinning. The stress required for twinning at 4.2°K was less than the flow stress at 77°K; the strain rate sensitivity was either zero or negative where twinning predominated. NSA

N68-26846*# National Aeronautics and Space Administration, Washington, D. C.
ALLOYING PRINCIPLES AND STRENGTHENING MECHANISMS Discussion Supplements for Committee 5 Report
G. Mervin Ault 16 July 1967 49 p refs Presented at the NATO Conf. on High Temp. Behavior of Refractory Mater., Sandefjord, Norway, 31 Jul.–5 Aug. 1967
(NASA-TM-X-60337) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Supplementary data are presented on various aspects of the high temperature behavior of refractory materials. Guidelines developed in the United States by the Materials Advisory Board Refractory Sheet Rolling Panel are combined with observations on the current state of the art to assess the emerging trends for high strength refractory metal alloys. Research findings on ductile–brittle transition temperatures in tungsten and chromium are reviewed, with attention centered on the importance of interstitials, contamination, and processing for improving the alloys. Experimental data on strengthening refractory metals are also reviewed, and summary results are presented on the strengthening of carbon and boron in tungsten and on carbide-strengthened alloys. Illustrative data are included on the relationship of grain size to strength which suggest that greater tensile and creep strengths may be associated with finer grain sizes. Consideration is also given to a concept whereby the refractory metal alloys might be converted to wire and embedded in a superalloy matrix with superior oxidation resistance. Reference bibliographies are included. M.G.J.

N68-26859*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE APPLICATION OF DIRECTIONAL SOLIDIFICATION TO A NASA NICKEL-BASE ALLOY (TAZ-8B)
John C. Freche, William J. Waters, and Richard L. Ashbrook Washington 1967 27 p refs Presented at SAE Natl. Congr., Detroit, 8–12 Jan. 1968
(NASA-TM-X-52346) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The nickel-base alloy, TAZ-8B, has been developed which compares favorably in high temperature strength with known high strength nickel-base alloys. Although basically a cast material, the alloy also possesses workability potential. By applying directional solidification techniques test specimens were produced with a preferred columnar grain orientation. Grain boundaries transverse to the major stress axis were largely eliminated. Substantial increases in ductility, ultimate tensile strength, and stress-rupture life were obtained with the alloy in the directional polycrystalline condition as compared to the random polycrystalline condition. For example, the 1400°F ductility which was 3 percent in the random

polycrystalline form, was increased to 6 percent in the directional polycrystalline form. Ultimate tensile strength was similarly raised from 144,000 to 172,000 psi at this temperature. The 1000, 100, and 10 hour use temperatures at 15,000 psi are 1785°, 1925° and 2025°F in the conventional random polycrystalline form and 1830°, 1940° and 2040°F in the directional polycrystalline form. Author

N68-26949# Iowa State Univ. of Science and Technology, Ames.
THE INFLUENCE OF PRECIPITATES ON THE BRITTLE-DUCTILE TRANSITION OF CHROMIUM
Robert Clark Tucker, Jr. (Ph.D. Thesis) 1967 81 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8939

The effects of heat treatment and nitrogen concentration on the brittle-ductile transition temperature and related properties of chromium have been investigated. Aging oil quenched chromium–nitrogen alloys at temperatures below 455°C produces, as a function of aging temperature at any given nitrogen concentration, a decrease in transition temperature, an increase in yield strength, continuous incremental increases in resistance ratios, and a maximum in hardness at about 300°C. The alloys contain small coherent or semi-coherent particles, larger incoherent hexagonal $Cr_2N_{\{001\}_\alpha}$ precipitates with $\{100\}_\alpha$ habit planes, and, at higher concentrations of nitrogen, hexagonal Cr_2N precipitates of the same structure but with $\{112\}_\alpha$ habit planes. Averaging at 455°C results in the solution of the small particles and precipitation of additional $Cr_2N_{\{001\}_\alpha}$. A model is proposed to explain some of the aging effects based on the density and morphology of the Cr_2N precipitates formed during quenching and on the precipitation of the nitrogen retained in solution upon quenching as small particles of varying coherency and their subsequent solution and reprecipitation on pre-existing Cr_2N or as new $Cr_2N_{\{001\}_\alpha}$ particles. Dissert. Abstr.

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N68-25663# Iowa State Univ. of Science and Technology, Ames.
MECHANICAL STRENGTH OF MIXTURES OF MAGNESIUM OXIDE AND CALCIUM FLUORIDE FROM ROOM TEMPERATURE TO 1000°C
F. W. Calderwood and D. R. Wilder Aug. 1967 29 p refs
(Contract W-7405-ENG-82)
(IS-1632) CFSTI: HC $3.00/MF $0.65

The effect of additions of calcium fluoride on the hot load strength of a refractory grade of magnesium oxide was studied. Specimens were prepared by powder-pressing rectangular bars, shaping the bars with a reduced cross-section at the mid-point, and finally, sintering the bars at 1800°C under a helium atmosphere in a molybdenum resistance furnace. Fired specimens were stressed to failure by the cross-bend method under an oxidizing atmosphere in a globar furnace. Several specimens were tested at each temperature-composition point, and the resulting data were treated by statistical methods. Specimens containing no calcium fluoride were found to have greatest resistance to rupture at temperatures of 500°C and below. Between 500 and 1000°C, results were more erratic, but specimens usually showed greater strength with the increase of calcium fluoride up to 8 mole %. At 1000°C, the specimens with no additive again showed greater strength. Author (NSA)

N68-25884*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE EFFECTS OF MOLECULAR STRUCTURE ON THE THERMOCHEMICAL PROPERTIES OF PHENOLICS AND RELATED POLYMERS
J. A. Parker, E. L. Winkler, B. H. Miles (Dow Chem. Co., Freeport, Tex.), and L. F. Sonnabend (Dow Chem. Co., Midland, Mich.) [1967] 28 p refs
(NASA-TM-X-59844) CFSTI: HC $3.00/MF $0.65 CSCL 11I

The char forming reactions of phenolic resins and related polymers are explained in terms of a general pyrolysis mechanism. Based on this mechanism, an analysis was developed which predicts, from molecular structure, the observed thermogravimetric char yields accurately over a range from 11 to 65% yield. The analysis can be applied to control the primary rates of vapor to char production for a particular heat shield application. Composites from these polymers were developed and tested under one dimensional pyrolysis simulating reentry ablation. At heating rates up to 25 cal cm^{-2} sec^{-1}, the char yields agree well with those obtained in thermogravimetric tests or calculated from analysis. The primary char forming processes with these materials seem to be independent of polymer heating rate over temperature rise rates ranging from 2° to 5000°C/min. With certain composites and at heating rates greater than 25 cal cm^{-2} sec^{-2}, additional char is formed due to secondary pyrolysis of vapor products within the char matrix induced by high char temperatures. R.N.A.

N68-26020# Tokyo Univ. (Japan). Inst. of Industrial Science.
GLASS-FORMATION RANGES OF TERNARY SYSTEMS. PART 1: SILICATES OF A-GROUP ELEMENTS
Minoru Imaoka and Toshiko Yamazaki Mar. 1968 33 p refs In JAPANESE; ENGLISH summary *Its* Vol. 19, No. 4, Serial No. 118
CFSTI: HC $3.00/MF $0.65

Graphical and tabulated data are presented on the glass formation ranges of ternary silicate systems. The composition of the melts (mol o/o) are given for each system, and the figures depicting the experimental results are marked to indicate clear glass, opaque glass, partially opaque glass, crystal, a glass containing a crystalline part, and an insufficient melt. M.G.J.

N68-26106*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A SURVEY OF THE PHOTODEGRADATION OF ORGANIC POLYMERS EXPOSED TO ULTRAVIOLET RADIATION
Ronald F. Reinisch and Hermilo R. Gloria [1967] 20 p refs Presented at the 3d Ann. Meeting of the Solar Energy Soc. Conf., Tempe, Ariz., 20–22 Mar. 1967
(NASA-TM-X-59805) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Some of the variables involved in the photodegradation of organic polymers are examined, with special emphasis given to research on the photochemistry of poly(vinyl chloride). Attention is focused on those variables that are critical to the successful UV stabilization of polymers. The discussion will center about the nature of the ultraviolet absorbing grouping, the wavelength dependence of the photochemical reaction, and the rate enhancing effect of polychromatic radiation. The absorption spectra of the ultraviolet absorbing groups present in PVC film was measured by means of single-beam spectrophotometry. These groups are identified as polyenes on the basis of comparison with known polyenes and the wavelength dependence curve of color development. The interaction of the pi-electrons of the polyenes initially present in PVC with antimony trichloride markedly retarded the rate of photodegradation. Useful criteria are presented for the choice of energy-transfer systems for the UV protection of PVC. Monochromatic quantum yields of photolysis for a variety of linear polymers are compared. Author

N68-26125# Technische Hochschule Munchen (West Germany). Inst. fuer Technische Mechanik.
EXPERIMENTAL INVESTIGATIONS OF THE BEHAVIOR OF BRITTLE MATERIALS AT VARIOUS RANGES OF TEMPERATURE Scientific Annual Report, 1 Apr. 1965–30 Sep. 1966
Heinz Neuber and Anton Wimmer Wright-Patterson AFB, Ohio AF Mater. Lab. Mar. 1968 107 p refs
(Contract AF 61(052)-875)
(AFML-TR-68-23; AD-668148)

Youngs modulus, the fracture stress and the fracture strain (strain at fracture) of Alumina (Al2O3) were determined in a temperature range from -200C to 1200C by bending tests and the influence of the porosity, the grain size, the strain rate, the specimen diameter and length on these quantities was investigated. The bending tests were also extended in the same temperature range to other oxide ceramic materials like Magnesia (MgO), Zirconia (ZrO2) and Spinel (Al2O3 . MgO). Temperature treatments were undertaken on Alumina specimens in the temperature range from 1000C to 1600C and the change of the porosity and the grain size was observed. Bending tests were carried out for the determination of Youngs modulus for tension and compression. Author (TAB)

N68-26202# Army Natick Labs., Mass. General Equipment and Packaging Lab.
THE MECHANICS OF RUPTURE OF COTTON-DACRON BLENDED YARNS
Constantin J. Monego Jul. 1967 239 p refs
(TR-68-16-GP; AD-667931)

The tensile behavior of cotton-Dacron blends was studied in a twisted model yarn structure composed of Dacron filament yarns (70 denier, 34 filament) and combed cotton staple yarns (79 cotton content (c.c.)) in blend ratios of 1.1, 2.2, 11, 22, 33, 44, 56, 67, and 89 percent cotton content. The contribution of the cotton component to the blended structure at all strain levels is the main subject of the study. The report covers the experimental studies on the load extension characteristics of 72 model yarns at elongations of 5 percent through break and the effect of twist (0.55 twist multiple (TM) through 4.4 TM), blend ratio and position of the cotton component in the yarn (cotton core or cotton shell) on the strength of the blended yarn are discussed. These studies extend Machidas theoretical approach to the problem of blended yarn strength to include cotton-Dacron blended yarns in blend ratios of practical significance. Author (TAB)

N68-26274*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RIGID OPEN CELL POLYURETHANE FOAM AS A CRYOGENIC MULTI-LAYER INSULATION COMPONENT
J. R. Faddoul and C. R. Lindquist (Union Carbide Corp., Tonawanda, N. Y.) Washington 1967 32 p ref Presented at 12th Ann. Tech. Conf. of the Soc. of the Plastics Ind., Cellular Plastics Div., Washington, D. C., 16–18 Oct. 1967
(NASA-TM-X-52332) CFSTI: HC$3.00/MF$0.65 CSCL 11I

The application of a rigid, open cell polyurethane foam as a spacer material in a self-evacuating multi-layer insulation system for long term storage of cryogenic propellants in space is described. The form is prepared in buns and sliced to about 0.020 inches thick. Double aluminized Mylar radiation shields are employed and a laminate of aluminized Mylar is used for the insulation panel casings. The panels are filled with a condensible gas which, upon cooling one surface of the panel to liquid hydrogen temperature, cryopumps to a pressure below 10^{-4} torr to affect the required insulation performance. Panels are arranged in a shingled fashion to insure that each individual panel has sufficient surface at liquid hydrogen temperature. A number of spacer configurations are described which were investigated to achieve improved thermal performance and speed of evacuation. Thermal conductivity and gas conductance data for the various configurations of the form are included. A large scale test of one of the panel systems on a calorimeter tank is described. Author

N68-26291*# Boeing Co., Seattle, Wash. Saturn Booster Branch.
EFFECTS OF PROCESSING VARIABLES ON BOND STRENGTH OF POLYURETHANE ADHESIVE
R. O. Koch 1967 32 p refs
(Contract NAS8-5608)
(NASA-CR-61808; T5-6556-16) CFSTI: HC $3.00/MF $0.65 CSCL 11A

Laboratory tests and literature surveys were conducted to evaluate several processing variables with respect to a polyurethane adhesive bonding process. Evaluated were variables such as bond line thickness, adherend etchant, and adherend primers. Findings indicate: (1) Room temperature peel adhesion will be improved by increasing the bondline thickness; yet room temperature lap shear and cryogenic peel and lap shear will not be significantly affected. (2) the present 60B32067 paste etchant formulation is satisfactory. (3) The incorporation of a silane type primer or equivalent into the 60B32067 bonding process will significantly increase bondline resistance to moisture degradation. Author

N68-26299# Air Force Systems Command, Wright-Patterson AFB, Ohio. Materials Lab.
APPLICATION OF THE PLATE TWIST TEST TO LAMINATED COMPOSITES Technical Report, Jun.–Sep. 1967
James M. Whitney Mar. 1968 20 p refs
(AFML-TR-67-407; AD-668477)

The laminated plate theory is used to show that the applicability of the plate twist test for measuring shear modulus of laminated fiber-reinforced composites is limited to cross-ply layups and unsymmetric angle-ply layups. Numerical examples for symmetric plus or minus 45-degree boron-epoxy and glass-epoxy composites are used to illustrate the magnitude of the error generated when this test is used incorrectly. Results show errors of over 100% can occur. It is also concluded from laminated plate theory that the shear modulus for angle-ply composites can be considerably higher than the shear modulus of a unidirectional ply oriented at an angle of zero degrees to the plate axes. For example, the shear modulus of each layer of a plus or minus 45-degree boron-epoxy angle-ply composite containing 70% fiber by volume is approximately 3,500,000 PSI, while the composite shear modulus is 10,500,000 PSI. Author (TAB)

N68-26346# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF UV RADIATION AND VACUUM ON STRENGTH AND DESTRUCTION OF POLYMER FILMS [VLIYANIYE UF IZLUCHENIYA, VAKUUMA NA PROCHNOST' I RAZRUSHENIYE POLIMERNYKH PLENOK]
L. M. Polyakov 18 Aug. 1967 17 p refs Transl. into ENGLISH from Mekh. Polimerov (USSR), no. 3, 1966 p 359–364
(FTD-MT-24-184-67; AD-668098)

The effect of UV radiation on the mechanical properties of poly(ethylene terephthalate) (PETP) films was studied. The changes were noted in tensile strength and deformation, and the formation of defects, i.e., cracking. The samples used were strips of PETP film, 6 mm wide, 20 mm long and 10 microns thick. The irradiated samples were subjected to tensile strength tests on a special machine. It was found that open cracks developed on the irradiated side of the samples if the irradiation took place in air. Vacuum-irradiated samples developed cracks only on deformation during the tensile test. A weakening of molecular bonds during the irradiation was assumed. Cracking began at definite stresses and deformation which decreased with an increase in the radiation dose. The tensile strength and plasticity of the irradiated films decrease with an increase in the duration of irradiation. The

air-irradiated samples display a higher loss in tensile strength than the vacuum-irradiated samples, which suffer a higher loss in plasticity. Vacuum-irradiated samples form no visible defects on the surface: their surface remains smooth even after rupture of the sample. Author (TAB)

N68-26373# Whittaker Corp., San Diego, Calif. Warmco Research and Development Div.

INVESTIGATION OF MICROMECHANICAL BEHAVIOR OF FIBER REINFORCED PLASTICS Final Report, 14 Jun. 1966–14 Mar. 1967

Juan Haener, Noel Ashbaugh, Chuen-Yuan Chia, and Ming-Yuan Feng Feb. 1968 233 p refs

(Contract DA-44-177-AMC-441(T))

(USAAVLABS-TR-67-66; AD-667901)

The stress fields in the components of a unidirectional composite due to shrinkage and external loads are computed for 20 matrix/reinforcement combinations having various volumetric contents. Further, the load transmissions between loaded and unloaded fibers are formulated as three-dimensional elasticity solutions. The instability problem of a composite is treated by both the static and the energy method, resulting in critical loads and buckling wavelengths which depend on material constants and geometries. The theoretical results are in good agreement with experiments. The work reported herein encompasses the following principal areas: (1) parametric studies (internal stresses and displacements computed for unidirectional composites comprised of different matrices and reinforcements combinations and different volumetric contents); (2) three-dimensional load transfer among loaded and unloaded fibers in a matrix; (3) buckling of fibers in a matrix under axial load as an elasticity solution; (4) the buckling of fibers in a matrix under axial load, solved with the Ritz-Galerkin method; and (5) buckling of fibers in a matrix due to matrix shrinkage. Author (TAB)

N68-26449# Los Alamos Scientific Lab., N. Mex.

CMF-13 RESEARCH ON CARBON AND GRAPHITE Progress Summary Report, 1 Nov. 1967–31 Jan. 1968

Morton C. Smith 9 Feb. 1968 25 p refs

(Contract W-7405-ENG-36)

(LA-3872-MS; Rept.-4) CFSTI: HC $3.00/MF $0.65

Properties and structure of extruded graphite prepared from graphite flour and carbon black were determined. Techniques were investigated for deagglomerating and preparing carbon blacks. Differential thermal analyses were made of furfuryl alcohol resins and furfuryl alcohol–formaldehyde copolymers. Grinding of Ceylon natural graphite and high-expansion coke graphite was studied and hot-molded, pitch-bonded graphite was prepared. The effect of particle size distribution on properties of graphite was determined. X-ray diffraction was used to study the crystalline properties of made and natural graphites. Crystalline structures were used to evaluate the effect of filler type on pitch concentrations of molded graphites. X-ray parameters are given for pyrolytic glassy carbons. The effect of temperature on creep of graphite was studied at 2100 and 2500°C. Experiments were conducted on swiveling pyrolytic graphite. NSA

N68-26512 Brown Univ., Providence, R. I.

ELECTRON SPIN RESONANCE SPECTRA OF γ-RAY IRRADIATED GERMANATE, PHOSPHATE, AND ARSENATE GLASSES

Robert Andrew Weeks (Ph.D. Thesis) 1966 101 p

Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-2299

Alkali-germanate glasses with molar ratios of GeO_2/Na_2 in the range from 333 to 3.33 were irradiated with ^{137}Cs γ-rays to a dose of $\approx 3 \times 10^8$ roentgens at a temperature of ≈35°C. Electron spin resonance (ESR) measurements at ≈10 Gcps were made at ≈300° and 78°K. At ≈300°K the spectra was composed of two well resolved asymmetric resonances whose shapes corresponded to the shape expected for the powder-line shapes of paramagnetic centers with axially symmetric g-tensors and with a spin state S = 1/2. Assuming that the resonances are due to centers with axial symmetry, the principal values of the g-tensor for one center are $g_{\parallel} = 2.0016 \pm 0.0006$ and $g_{\perp} = 1.9960 \pm 0.006$, and for the second center $g_{\parallel} = 2.003 \pm 0.001$ and $g_{\perp} = 2.090 \pm 0.001$. For constant irradiation conditions the concentration of centers with the smaller g-values decreased with decreasing molar ratio, while the concentration of centers with the larger g-values increased initially with decreasing molar ratio. Dissert. Abstr.

N68-26534# Gulf General Atomic, San Diego, Calif.

RESEARCH ON GRAPHITE Quarterly Progress Report, 15 Aug.–14 Nov. 1967

J. C. Bokros, G. B. Engle, and R. J. Price 22 Nov. 1967 60 p refs

(Contract AT(04-3)-167)

(GA-8376) CFSTI: HC $3.00/MF $0.65

Mesophase material from an extracted impregnated pitch was subjected to densitometric separation. Density was found to increase with increasing heat treatment temperature. A low-density residue found above 2200°C was attributed to closed porosity generated at high temperature. A correlation between crystallite size and apparent density of artificial graphite was confirmed. Experiments with near isotropic graphite showed a narrow range of crystallite size over a wide range of density. The effects of metallic catalysts in the preparation of cokes from coal-tar pitch or petroleum asphalt with finely divided Zr are being investigated. Samples heated in air to about 600°C using this method did not graphitize well when heated to 2800°C. Thermal expansivity increases were observed in calcined coke when re-irradiated in a reactor. An equation which relates bulk volume changes to volumetric changes is given. Radiation-induced changes were studied in isotropic pyrolytic carbon. An accelerated rate of change was noted at high neutron exposures. Property measurements were made on irradiated pyrolytic carbons with and without Ti additives. Density increased with annealing temperature. Electric conductivity increased with apparent crystallite size. NSA

N68-26540 Rutgers Univ., New Brunswick, N. J.

A CONSIDERATION OF THE THERMAL-ELASTIC EFFECT IN GLASSES

Douglas Milton Mattox (Ph.D. Thesis) 1966 134 p

Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8193

Studies of internal friction spectra in glasses have not yet realized their potential as an analytical tool as they have in the study of metals. An apparatus is described here which overcomes several previous drawbacks to such studies in glass. The internal friction as a function of frequency is studied in glass fibers vibrating in the transverse mode. The form of excitation does not rely on the use of transducers, but instead uses the influence of a constant electric field or an alternating electric field on a fiber. Fibers of low natural frequency (less than 25 cps) are displaced in an electric field of 500V/cm, and the decay of vibration in vacuum is recorded upon removal of the field. The amplitude of vibration is plotted against frequency. Amplitude and frequency of vibration are assumed to be proportional to the signal induced on a phototube by the projected image of the vibrating fiber. The size (1mm) and natural frequency of glass fibers which may be excited by this technique cover the frequency range in which the thermal-elastic effect can be observed. Dissert. Abstr.

N68-26573# Army Electronics Labs., Fort Monmouth, N. J.
PYROLYTIC DECOMPOSITION STUDIES OF TETRAETHOXYSILANE FOR OBTAINING HIGH-GRADE SILICON OXIDE FILMS
George W. Heunisch Dec. 1967 24 p refs
(ECOM-2918; AD-667897)

Silicon oxide can be produced by decomposition of alkoxy silane compounds, and, under certain conditions, thin films of silicon oxide can be deposited over metal substrates. Tetraethoxysilane was chosen for study because of its high oxygen content, making possible clear, thick films (1-3) and the low temperature needed for decomposition. An investigation was made of several means of decomposition. One of these - bulk liquid and liquid solutions - proved unsuitable for producing the desired films. Liquid phase reactions tend to produce polymers or amorphous solids and include incompletely reacted material with the deposit. Gas phase decompositions, on the other hand, produce hard, insulating films. A flowing system similar to that used by the electronics industry was evaluated and compared with a new closed tube system, which has been designed and fabricated to help overcome difficulties encountered with the flowing system. With the closed tube, films can be conveniently deposited on varied substrates, thus providing unique environments for the study of their chemical and electrical properties. Author (TAB)

N68-26657 Brown Univ., Providence, R. I.
A STRESS WAVE STUDY OF BRITTLE FRACTURE
Dennis Rader (Ph.D. Thesis) 1966 132 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-2280

The phenomenon of brittle fracture in glass and two glassy polymers (polystyrene and polymethylmethacrylate) has been investigated for very high rates of loading by means of stress wave propagation and reflection. In these two types of materials, a comparison of their (higher) dynamic strengths with values observed in the quasi-static loading range has helped to elucidate their respective mechanisms of fracture. In glass the increase in strength over this range was found to be about 50 per cent. In the polymers, it is found that the fracture strength increases by about the same amount as the "elastic" modulus in going from quasi-static to dynamic loading. I is thus concluded that strain is the dominant factor in the fracture of the glassy viscoelastic materials tested. A series of experiments were performed in plate specimens in which dynamic crack growth was observed with a high speed camera. The crack patterns established in a plate by an impulsively applied surface force (or impact) have been investigated in terms of the cylindrical stress pulse which diverges from the point of load application. Dissert. Abstr.

N68-26667# Stanford Research Inst., Menlo Park, Calif.
GROWTH, PROCESSING AND CHARACTERIZATION OF β-SILICON CARBIDE SINGLE CRYSTALS
Robert W. Bartlett and Robert A. Mueller Feb. 1968 44 p refs
(Contract F19628-67-C-0243; SRI Proj. PMU-6488)
(AFCRL-68-0166; SR-2; AD-669099)

Vapor deposition of beta-silicon carbide on (111) beta-silicon carbide platelets is being studied using methyltrichlorosilane or mixtures of silane and propane. Although epitaxial deposits were achieved with either source gas, low octahedral steps (triangles) and numerous intergrown star-shaped hillocks on the alternate side usually occur. Process conditions were systematically varied to improve the surface perfection, and n-type epitaxial layers with smooth surfaces free of hillocks were grown on n-type beta-silicon carbide crystal substrates using CH3SiCl3. Epitaxial deposits of n-type beta-silicon carbide were grown on aluminum-doped p-type silicon carbide substrates, and p-type epitaxial deposits were grown on n-type crystals using diborane for p-doping during vapor deposition. Processing of diodes requires a suitable etching procedure. Hydrogen etching through thermally grown oxide masks was not successful because of reduction of the oxide. Construction of apparatus for oxygen/chlorine etching of silicon carbide at modest temperature using oxide masking is ninety percent complete. A crude electroluminescent, epitaxial diode was demonstrated using a beta-silicon carbide crystal consisting of a p-type epitaxial layer deposited on an n-type substrate. Author (TAB)

N68-26694# Battelle Memorial Inst., Columbus, Ohio. Defense Ceramic Information Center.
A REVIEW OF GLASSLIKE CARBONS
Shigehiko Yamada (Tokai Electrode Mfg. Co., Ltd.) Apr. 1968 54 p refs
(Contract F33615-67-C-1472)
(DCIC-68-2; AD-668465)

A relatively new group of carbons having several characteristics resembling glass is of sufficient interest in connection with technological demands for improved materials to prompt this report. The generic term glasslike is appropriate for these carbons because they exhibit a glassy surface appearance, conchoidal fracture, internal-friction characteristics resembling glass more closely than normal graphite, and gas impermeability comparable to glass. The structure of glasslike carbons is not well understood; it resists change by graphitization at temperatures up to about 3000C. The report reviews the preparation, formation mechanisms, structure, properties, and applications of glasslike carbons. The unique combination of properties and resulting potential applications has stimulated manufacture of glasslike carbons by several companies. Available property data on the various products are included. TAB

N68-26874*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THERMAL DEGRADATION STUDIES OF SEVERAL PYRRONE FILMS
Robert A. Jewell [1966] 22 p refs Presented at the 18th Southeastern Regional Meeting of the Am. Chem. Soc., Louisville, Ky., 27–29 Oct. 1966
(NASA-TM-X-60323) CFSTI: HC $3.00/MF $0.65 CSCL 11I

The thermophysical behavior of several polyimidazopyrrolone (Pyrrone) polymers was investigated to relate chemical structure to thermal stability, and to aid the direction of exploratory synthesis of this class of aromatic/heterocyclic materials. Combining some of the desirable chemical and physical properties of the polyimides and the polybenzimidazoles, the Pyrrones hold considerable potential for specialized aerospace and terrestrial uses. Thermogravimetric analysis (TGA) in air and in vacuum of four films from these step-ladder materials suggests some preliminary indication of ways to improve their thermal stabilities. Both isothermal and dynamic heating were used to derive rates of volatilization and activation energies. The comparison of TG curves, as well as the results from other measurements such as differential thermal analysis (DTA) and residual gas analysis, were used to detail the modes of thermal degradation. Author

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N68-25672# Forsvarets Forskningsanstalt, Stockholm (Sweden).
CONVERGENCE AND COST MINIMIZATION IN QUEUING SYSTEMS OF THE TYPE (D,M,1)
Gunnar R. Grape Mar. 1968 17 p refs *Its* FOA Rept., Vol. 2, No. 1
CFSTI: HC $3.00/MF $0.65

A queuing system with exponentially distributed service times and constant interarrival times is studied for the case of one service station. For this system the convergence toward the steady state is determined as well as the interarrival times between customers and the initial conditions that minimize the combined costs of keeping customers waiting and service station idle. The results are given numerically for the finite case where a predetermined number of customers are to be served. Author

N68-25686*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A COMPARATIVE ANALYSIS OF TWO CONCEPTS IN THE GENERATION OF UNIFORM PSEUDO-RANDOM NUMBERS

George C. Canavos [1967] 34 p refs Presented at the Assoc. for Computing Machinery, 20th Anniv. Meeting, Washington, D. C., 29–31 Aug. 1967

(NASA-TM-X-60370) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The well-known congruence algorithm of the form $X_{i+1} = aX_i + b \bmod m$ in uniform random number generation suffers considerably in its adaptation because it is mostly a function of computer word length. This concept is compared with another, introduced by R. C. Tausworthe, which is based on a linearly recurring sequence of zeros and ones derived from an nth degree primitive polynomial over the Galois field of order two. An inherent advantage of this concept is that it is entirely machine independent. The empirical analysis of the two concepts shows the statistical behavior of the latter one to be at least as good if not superior to its congruential counterpart. Author

N68-25841*# Innsbruck Univ. (Austria).

LIE SERIES FOR CELESTIAL MECHANICS, ACCELERATORS, SATELLITE STABILIZATION AND OPTIMIZATION

F. Cap, F. Ehlotzky, D. Floriani, W. Groebner, H. Knapp et al Washington, D. C. NASA May 1968 202 p refs

(Grant NGR-52-046-001)

(NASA-CR-1046) CFSTI: HC $3.00/MF $0.65 CSCL 12A

An overview is presented on some of the research work done in the field of Lie series and their physical, technical, and practical applications. The following problem areas are considered: (1) solution of a system of n-th order differential equations; (2) solution of differential equations resulting from the separation of Laplace equation in various coordinate systems; (3) numerical computation of satellite orbits; (4) calculation of particle orbits in accelerators; (5) optimization problem of soft landing on the moon with fuel minimization; and (6) equations of motion of satellites. An extensive bibliography of work done using Lie series is also included. A.L.

N68-25869*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A LEAST SQUARES METHOD FOR THE REDUCTION OF FREE-OSCILLATION DATA

Phillip R. Wilcox and William L. Crawford Washington Jun. 1968 29 p refs

(NASA-TN-D-4503) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The classical least squares curve fitting method is used to determine the frequency, amplitude, damping ratio, phase angle, and zero offset of both a one- and two-degree-of-freedom system from free oscillation data. The method is applied to a number of experimental transients with good results. Where possible, comparisons are made with the results of other methods. The least-squares method is found to be particularly useful in the analysis of two-degree-of-freedom systems where other techniques are difficult or impossible to apply. Author

N68-25943*# New York Univ., N. Y. Lab. for Electroscience Research.

AN APPROACH TO THE PROBLEM OF RECONSTRUCTING POLYHEDRA FROM TWO OR MORE OF THEIR PERSPECTIVE PROJECTIONS

Andrew D. Rabinowitz Apr. 1968 44 p refs

(Grant NGR-33-016-038)

(NASA-CR-94932; TR-400-181) CFSTI: $3.00 CSCL 12A

This report is an investigation into the problem of reconstructing a three-dimensional geometrical description of polyhedral objects from two or more of their perspective projections. A classification scheme for subdividing the problem according to projection and object characteristics is presented. Some basic techniques for the reconstruction are described. Author

N68-25990 State Univ. of Iowa, Iowa City.

PROJECTIONS IN LOCALLY CONVEX SPACES

Mark David Levin (Ph.D. Thesis) 1967 52 p

Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-9076

A locally convex space E is said to be of type *P* when for every locally convex space F containing E as a subspace there is a continuous projection from F onto E. LEMMA. If q is a continuous seminorm on metrizable locally convex space E such that the norm-induced topology by q and quotient topology on E/N agree where $N = q^{-1}(0)$ and N is complete, then for any Banach space G containing E/N there exists Fréchet space F containing E such that G = F/N with the quotient topology. THEOREM A. If E is a locally convex space of type *P*, then there is a family Φ of seminorms on E which generate the topology of E and such that if p is a member of Φ, then (a) the norm-induced topology by p and quotient topology on E/N agree where $N = p^{-1}(0)$, and (b) E/N is a type *P*. THEOREM B. Every quotient space of a Banach space of type *P* is of type *P*. An elementary theory of locally convex spaces of type *P* is developed. Finally, locally convex spaces with families of seminorms satisfying condition (a) are investigated. Dissert. Abstr.

N68-26047 Rochester Univ., N. Y.

MINIMAL INTERACTIONS, CURRENT ALGEBRA AND APPLICATIONS

Jagadisan Pasupathy (Ph.D. Thesis) 1967 107 p

Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8968

The hypothesis of minimal electromagnetic interaction is extended to weak interaction and the partially conserved axial vector current equation is modified to $\partial_\mu J^{\mu i}_\mu = C\phi^i + \epsilon^{ijk} W_\mu J^{\mu k}_\mu$. Equation (1) is shown to be valid in theories which treat the vector and axial vector currents symmetrically like the quark model and the σ-model but not in unsymmetrical theories like the pseudoscalar or the pseudovector pion nucleon interaction. Equation (1) is sufficient to derive all the low energy applications of current algebra. The application to soft-pion production by electron and neutrino is discussed at length. Using projection operators for SU(3) representations the group theoretical equations are solved. The form factors in the elastic reactions are related to those in the inelastic reactions. The conclusion that the axial vector radius is nearly equal to the vector radius is reached. Following the method of Weinberg the procedure for studying processes with two soft pions is outlined. Dissert. Abstr.

N68-26053 Rochester Univ., N. Y.

MALGRANGE THEOREM FOR NUCLEARLY ENTIRE FUNCTIONS OF BOUNDED TYPE ON A BANACH SPACE

Chaitan Prakash Gupta (Ph.D. Thesis) 1967 86 p

Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8953

We generalize here Malgrange's results (see also Schwartz, Treves, Hörmander concerning approximation of solutions of homogeneous convolution equations and existence of solutions of

homogeneous convolution equations with a second member. We deal with a certain vector subspace $H_{Nb}(E)$ of the space $H(E)$ of entire functions on a complex Banach space E. This vector subspace happens to coincide with $H(E)$ when E is finite-dimensional, and it is different from $H(E)$ when E is infinite dimensional. We use the notation and the theory of holomorphic mappings on an open subset U of a complex Banach space E with values in a complex Banach space F as developed by Nachbin (see also Douady), and the theory of topological tensor products and nuclear mappings due to Grothendieck (see also Schwartz). Dissert. Abstr.

N68-26195# Harvard Univ., Cambridge, Mass. Lab. for Computer Graphics and Spatial Analysis.
N-DIMENSINOAL SPATIAL ANALYSIS AND COMPUTER GRAPHICS, PART A
C. Ernesto and S. Lindgren 24 Apr. 1968 60 p refs *Its* Harvard Papers in Theoret. Geography, Geography and the Properties of Surfaces Ser., Paper No. 16
(Contract N00014-67-A0298-0004)
(TR-16; AD-668405)

The paper, the first of a series with the same title, discusses the state of the art in n-dimensional methods of spatial analysis and selects one of such methods, developed within the last 10 years, proposing its application by means of computer graphics techniques. Author (TAB)

N68-26290# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
THE POWER OF SOME TESTS FOR UNIFORMITY OF A CIRCULAR DISTRIBUTION
R. J. W. Beran Jan. 1968 39 p refs
(Contract Nonr-4010(09))
(TR-78; AD-668150)

Let (x sub 1, x sub 2,...,x sub n) be independent observations on an arbitrary random variable which takes values on a circle of unit circumference. Suppose f(x) is a probability density in L sub 2(0,1). The main result of this paper is the asymptotic distribution of the class of test statistics T sub n = (1/n) multiplied by the integral taken between the limits 0,1 of the quantity (summation from j = 1 to j = n of f(x + x sub j)-n) squared dx. T sub n is used to test whether the observations are uniformly distributed on the circle. It includes as special cases several other statistics previously proposed for this purpose by Rayleigh, Watson, Ajne and others. Two distinct cases arise in the asymptotics -- for one class of alternatives T sub n yields a consistent test for uniformity, but for the others T sub n gives a test which is not consistent. A fair approximation to the power of T sub n can be obtained from its first two moments. The approximate Bahadur slope of T sub n is calculated from its asymptotic null distribution it does not appear to reflect the power of T sub n reliably. Author (TAB)

N68-26294# North Carolina Univ., Chapel Hill. Dept. of Statistics.
TABLES OF DISTRIBUTIONS OF QUADRATIC FORMS IN CENTRAL NORMAL VARIABLES 2
N. L. Johnson and Samuel Kotz (Temple Univ.) Dec. 1967 151 p ref *Its* Mimeo Ser. No. 557
(Grants AF-AFOSR-68-1415; AF-AFOSR-68-1411; NIH GMS-5R01GM-12868)
(AFOSR-68-0793; AD-668480)

The tables give values of the probability density and cumulative distribution functions of the random variable alpha sub 1 (U sub 1 squared) + alpha sub 2 (U sub 2 squared) + alpha sub 3 (U sub 3 squared) + alpha sub 4 (U sub 4 squared) + alpha sub 5 (U sub 5 squared) where the Us are mutually independent unit normal variables, with the alphas satisfying the condition alpha sub 1 + alpha sub 2 + alpha sub 3 + alpha sub 4 + alpha sub 5 = 5. The tables include sets of alpha values from (3.0, 0.5, 0.5, 0.5, 0.5) to (1.1, 1.1, 1.0, 0.9, 0.9) in all seventy sets of alpha values. The tabulated values, shown to five decimal places, are based on original calculations which should have an error less than 1 in the eighth decimal place. TAB

N68-26342# RAND Corp., Santa Monica, Calif.
SUBGRAPHS OF BIPARTITE AND DIRECTED GRAPHS
Jon Folkman and D. R. Fulkerson Apr. 1968 27 p refs
(Contract F44620-67-C-0045)
(RM-5604-PR; AD-668421)

The main theorem of this study provides necessary and sufficient conditions for a locally finite bipartite graph to have a subgraph whose valences lie in prescribed intervals. The theorem is applied to the study of integer-valued flows in locally finite directed graphs. In particular, generalizations of the max-flow min-cut theorem and the circulation theorem are obtained. The axiom of choice is assumed throughout. Author (TAB)

N68-26360# Brookhaven National Lab., Upton, N. Y. Applied Mathematics Dept.
AUTOMATIC GENERAL SOLUTIONS TO ALL-INTEGER INEQUALITIES
Richard D. Jenks Feb. 1968 32 p refs Sponsored by AEC
(BNL-12279) CFSTI: HC $3.00/MF $0.65

Automatic methods for obtaining general integer-valued solutions to $Ax \geq b$, $x \geq 0$, where A is a given integer-valued (n × m)-matrix and b is a given m-vector are analyzed. An algorithm having alternative two-way splitting rules is presented. Also, the fundamental theorem for the case $Ax = b$ is stated. NSA

N68-26379 California Univ., Berkeley.
ON CONSTANT ACTION SURFACES AND THE EXISTENCE OF A SIMPLE TRAJECTORY IN NONLINEAR CONSERVATIVE SYSTEMS HAVING MANY DEGREES OF FREEDOM
Chol Hui Pak (Ph.D. Thesis) 1966 72 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-8620

In a nonlinear, conservative, scleronomic system having many degrees of freedom, the notion of *constant action surfaces*, i.e., of the set of extremities of all trajectories originating from stagnation configurations and having equal action, is introduced to demonstrate the existence of a *simple trajectory*. It is shown that resonance occurs in the neighborhood of the frequencies and amplitudes belonging to simple trajectories. In the system considered here, the potential function is subjected to the following restrictions, (a) it is of class C^3 in the generalized coordinates, (b) it is symmetric about the origin of the configuration space and, (c) the locus of stagnation configurations, for a given energy level, is a closed connected hypersurface on which the gradient of the potential function does not vanish. A simple trajectory is that of a motion for which all masses vibrate equiperiodically, and have simultaneous rest points and simultaneous equilibrium positions. The problem of demonstrating the existence of a simple trajectory is formulated as one of variable end points in the calculus of variations in the large, making use of constant action surfaces. Dissert. Abstr.

N68-26383# Wisconsin Univ., Madison. Mathematics Research Center
SINGULARITIES DUE TO RE-ENTRANT CORNERS IN HARMONIC BOUNDARY VALUE PROBLEMS
J. R. Whiteman Dec. 1967 57 p refs
(Contract DA-31-124-ARO(D)-46?)
(MRC-TSR-829; AD-668399)

Numerical methods are presented for the solution of harmonic boundary value problems containing re-entrant corners. The methods are applied to a model problem containing a slit. Author (TAB)

N68-26401# RAND Corp., Santa Monica, Calif.
A CAUCHY PROBLEM FOR FREDHOLM INTEGRAL EQUATIONS WITH KERNELS OF THE FORM $K_1(/T - Y/) + K_2(T + Y)$
H. H. Kagiwada and R. E. Kalaba Apr. 1968 20 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5600-PR; AD-668423)

The report describes a method for converting Fredholm integral equations with spectral kernels into equivalent initial-value (Cauchy) problems that can be solved effectively by analog or digital computer. In this treatment the upper limit of integration, c, is viewed as an independent variable. An initial-value problem is derived for u(t, c), where u evaluated at a fixed point t is regarded as a function of c. The auxiliary functions R, e, and J, and the function u, satisfy differential-integral equations, subject to initial conditions. In the numerical method, the integrals in the differential equations are approximated by sums according to a quadrature formula. Then the system of differential-integral equations reduces to ordinary differential equations that can easily be solved by a computer. Author (TAB)

N68-26415# Wisconsin Univ., Madison. Mathematics Research Center.
SEQUENTIAL MONTE CARLO (REVISED)
John H. Halton Dec. 1967 40 p refs
(Contract DA-31-124-ARO/D/-462)
(MRC-TSR-816; AD-668394)

The paper explores the possibilities of constructing Monte Carlo sampling schemes incorporating sequential improvement of the estimator used. Three such schemes are suggested for the solution of problems reducible to linear systems of equations. Computational experience suggests that the methods are workable in practice (though sometimes requiring simplification to avoid excessive labor.) The present text is an extensive revision of a paper with the same title published in Proc. Camb. Phil. Soc. 58(1962) 57-78. Author (TAB)

N68-26419# Wisconsin Univ., Madison. Mathematics Research Center.
AUTOMATIC GENERATION OF TAYLOR COEFFICIENTS (TAYLOR) FOR THE CDC 1604
Allen Reiter Nov. 1967 98 p refs
(Contract DA-31-124-ARO/D/-462)
(MRC-TSR-830; AD-668397)

The report describes a CDC 1604 program designed to provide automatic means for a power-series expansion with respect to some real variable of a system of analytic functions of n real variables. The program can be used, for example, as a basis for the solution of systems of ordinary differential equations by successive expansions in power series. Author (TAB)

N68-26427# California Univ., Los Angeles. Operations Research Div.
RELAXATION AND THE DUAL METHOD IN MATHEMATICAL PROGRAMMING
Arthur Geffrion Mar. 1968 30 p refs *Its* Working Paper No. 135
(Contract Nonr-233(75))
(AD-668494)

The tactic of relaxation has often been used in one guise or another in order to cope with mathematical programs with a large number of constraints, some or all of which may be only implicitly available. By relaxation one means the solution of a given problem via a sequence of smaller problems that are relaxed in that some of the inequality constraints are temporarily ignored. Relaxation has been used primarily in the context of linear programming, but in this paper a version that is valid for a general class of concave programs is examined. Constraints are dropped as well as added from relaxed problem to relaxed problem. A specialization to the completely linear case is shown to be equivalent to Lemkes Dual Method. This result permits some pertinent inferences to be drawn from the extensive computational experience available for the (primal) Simplex Method. Other matters pertaining to computational efficacy are discussed. An interpretation of relaxation in terms of the dual in the nonlinear case is also established. The optimal multipliers generated by successive relaxed problems turn out to comprise a sequence of improving feasible solutions to the minimax dual. When interpreted in this way, it becomes apparent that relaxation corresponds to just the opposite tactic -- called restriction -- applied to the dual problem. Restriction is an equally interesting and useful tactic in its own right, and its main features are outlined. Author (TAB)

N68-26471# Wisconsin Univ., Madison. Mathematics Research Center.
NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS BY SPLINE FUNCTIONS (SPLINDIF)
Frank R. Loscalzo Jan. 1968 70 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-842; AD-668400)

A computer subroutine package, SPLINDIF, which implements a new method for obtaining global approximations to solutions of systems of non-linear first order differential equations with given initial values is described. The numerical solutions are spline functions of degree 2q with q continuous derivatives. The method is a one-step predictor-corrector scheme based on Hermites quadrature formula of 1878. The package consists of subroutines written in FORTRAN-63 for the CDC 1604 computer. This package uses TAYLOR, which is written in FORTRAN-63 and CODAP Assembly Language. Author (TAB)

N68-26474# Wisconsin Univ., Madison. Mathematics Research Center.
NONLINEAR EQUATIONS ARISING IN DEFERRED CORRECTION OF INITIAL VALUE PROBLEMS
James W. Daniel [1968] 14 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-818; AD-668393)

Nonlinear equations arising in the deferred correction method for initial value problems are related to advanced multi-step methods. Such methods are shown to be stable in the usual norm if the usual condition of stability for the approximation to the highest order differential term is satisfied. Author (TAB)

N68-26478# Research Analysis Corp., McLean, Va.
ON VARIABLE METRIC METHODS OF MINIMIZATION
John D. Pearson Feb. 1968 36 p
(Contract DA-44-188-ARO-1)
(RAC-TP-302; AD-666700)

Two basic approaches to the generation of conjugate directions are considered for the problem of unconstrained minimization of a quadratic function. Using the principle of choosing a step direction orthogonal to the previous gradient changes, a projected gradient algorithm and a class of variable metric algorithms are derived. Three variants of the class are developed into algorithms, one of which is the Fletcher-Powell-Davidon scheme. Numerical results indicate the merits of the new algorithms compared to several now in use, for a variety of nonquadratic problems. Author (TAB)

N68-26511# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
FUNDAMENTAL THEOREMS ON THE EXTENSION OF HERMITIAN OPERATORS AND SOME OF THEIR APPLICATIONS TO THE THEORY OF ORTHOGONAL POLYNOMIALS AND TO THE PROBLEM OF MOMENTS

M. G. Krein and M. A. Krasnosel'skii 14 Feb. 1968 78 p refs Transl. into ENGLISH from Usp. Mat. Nauk (Moscow), vol. 2, no. 3(19), 1947 p 60–106
(Contract NOw-62-0604-c)
(TT6-230-T 536; AD-668000)

Presented are various theorems on the extension of operators with a systematic use of a linear-fractional transformation of a linear operator. Also shown is that every Hermitian operator with dense domain of definition which has a spectral gap admits a self-adjoint extension and preserves the gap. The invariance of defect indices in the upper and lower half planes is proven for the case of arbitrary linear operators. Fundamental concepts dealing with linear operators in a Hilbert space are presented. Various examples appear throughout the paper showing the application of the derived theorems. They are taken from the theory of orthogonal polynomials and the problem of moments. Author (TAB)

N68-26544# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
DENSITY ESTIMATION BY ORTHOGONAL SERIES
Geoffrey S. Watson Apr. 1968 7 p refs
(Contract Nonr-4010(09))
(TR-90; AD-668155)

Given a random sample x sub 1...,x sub n from the density f(x) = Summation of (alpha sub m phi sub m(x)) where (braces) phi sub m(x) is an orthogonal basis, the estimator f star sub n(x) = Summation from zero to infinity of (lambda sub m(n) a sub m phi sub m(x)) where a sub m = (1/n) Summation from k = 1 to k = n, of phi sub m(x sub k) is suggested. f star sub n(x) will be a minimum integrated mean square error estimator in its class. These estimators are related to the kernel estimators discussed by Watson and Leadbetter (Ann. Math. Statist. 1963, 34, 480-491.). TAB

N68-26578# Wisconsin Univ., Madison. Mathematics Research Center.
ON COMPUTING BEST SPLINE APPROXIMATIONS
Larry L. Schumaker Jan. 1968 17 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-833; AD-668391)

An exchange algorithm for uniform spline approximation with prescribed knots is developed. Implementation and numerical experience are discussed, and an Algol program is appended. Author (TAB)

N68-26592 Cornell Univ., Ithaca, N. Y.
TOPOLOGICAL CONVEX SPACES
Serge Dubuc (Ph.D. Thesis) 1966 71 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-1461

My first task is to define what is a convex space without any reference to a vector space. The advantage of such a definition is that I can introduce the notion of topological convex space without using topological vector spaces. I verify that the most important of topological convex spaces of dimension n are simply convex subsets of R^n whose topology is induced by R^n. An interesting result is that in a locally convex topological convex space lower semi-continuous affine functionals separate points. From this fact, I know that the Krein–Milman theorem is true for a locally convex topological compact convex space. In R^n, extreme points can be very useful to prove Caratheodory, Kirchberger and Helly theorems. I study the notion of action on a convex space, an action is simply a family of affine transformations containing the identity mapping. I find sufficient conditions to insure the existence of a common fixed point for an action. The key theorem on abelian actions is the fact that the identity mapping is an extreme point of the set of affine transformations of a compact convex space. From this, I get a result of the following type: given a continuous affine transformation A, I can find an action $\mathcal{A}$, usually quite large, such that any fixed point for A is a common fixed point for $\mathcal{A}$. This theorem applied to convolution equations gives Choquet–Deny lemma. Dissert. Abstr.

N68-26598# Wisconsin Univ., Madison. Mathematics Research Center.
A CONVOLUTION STRUCTURE FOR JACOBI SERIES
Richard Askey and Stephen Wainger Dec. 1967 37 p refs
(Contract DA-31-124-ARO(D)-462)
(MRC-TSR-820; AD-668392)

The purpose of this paper is to show that there is a natural Banach algebra structure associated with expansions in Jacobi polynomials. Author (TAB)

N68-26630# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
BOUNDS FOR EIGENVALUES OF AN INTEGRAL OPERATOR
J. T. Stadter Feb. 1968 17 p refs
(Contract NOw-62-0604-c)
(TG-979; AD-668143)

The report illustrates the application of the method of intermediate problems for estimating the eigenvalues of integral operators. The method yields upper bounds to the positive eigenvalues of integral operators; lower bounds are obtained using the Rayleigh-Ritz procedure. Close bounds are given for eigenvalues of the operator with symmetric kernel K(x,y) = summation from i,j = 1 to i,j = infinity, of the quar ty (sin ix sin jy/(i to the 4th power + j to the 4th power)). Author (TAB)

N68-26649# Wisconsin Univ., Madison. Mathematics Research Center.
ON APPROXIMATION BY POLYNOMIALS HAVING RESTRICTED RANGES
L. L. Schumaker and G. D. Taylor Jan. 1968 15 p refs
(Contract DA-31-124-ARO(D)-462; Grant NSF GP-7624)
(MRC-TSR-835; AD-668395)

Existence and uniqueness of a best approximation by polynomials whose range is restricted to lie between lower and upper functions is obtained. In addition a computational algorithm for obtaining the best approximation is discussed. Author (TAB)

N68-26687# Wisconsin Univ., Madison. Dept. of Statistics.
THE VALUE OF PRIOR INFORMATION
Norman R. Draper and Irwin Guttman Dec. 1967 31 p refs
(Contract DA-31-124-ARO(D)-462)
(TR-135; AD-667926)

Sample y1,y2,...,yn of observations from some specified parent distribution, together with some prior information on one or more parameters of interest of the distribution. Then by applying Bayes theorem we can obtain the overall distribution (or the marginal distribution) if nuisance parameters are involved of parameters of interest, and can make inferences about these parameters. A natural question to ask is how inferences might be affected by a change in the prior distribution, i.e. by the availability of more, or less, information on the parameters. It would be convenient to have a quantity which could be used to indicate the value of more or less prior information. It is suggested, in this paper, for the one parameter case, the use of the ratio the expected values of the posterior variance of the parameter, expectation being taken over the future distribution of the sampling statistics which occur in the posterior variance. We illustrate the use of this ratio for a number of well-known distributions. Author (TAB)

N68-26733# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.

ON SOME RESULTS CONCERNING STOPPING RULES

Leon J. Gleser and S. Zacks (Kansas State Univ.) Feb. 1968 22 p ref

(Contract Nonr-4010(09); Grant NSF GP-7402)

(TR-83; AD-668152)

As a part of the investigation of sequential fixed-width confidence interval procedures for estimating the common mean of two distributions having unequal variances, it was found necessary to extend some of the results of Chow and Robbins (Ann. Math. Statist. 36 (1965) 457-462) to cover somewhat more general kinds of stopping rules. For example, although Chow and Robbins treat only one-sided stopping boundaries, the present investigation requires one to consider two-sided (or even many-sided) stopping boundaries. Further, some of the boundaries of interest have a slightly more general functional form than do the stopping boundaries discussed in the Chow-Robbins paper. The results given in the present paper provide first-order asymptotic results for the distribution and expected value of the various stopping variables N (the random number of observations taken) considered, the form of the results being similar to those announced in the Chow-Robbins paper referred to above. Author (TAB)

N68-26762# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.

ON LIMITING DISTRIBUTIONS FOR SUMS OF A RANDOM NUMBER OF INDEPENDENT RANDOM VARIABLES

Leon Jay Gleser Feb. 1968 19 p refs

(Contract Nonr-4010(09))

(TR-86; AD-668153)

The main result of the paper is a generalization of a theorem by Mogyorodi (Publ. Math. Inst. Hungar. Acad. Sci. 6, 365-371). This generalization of Mogyorodis theorem is applied to give simpler proofs, under less restrictive conditions, of some recent results of A. Albert (Ann. Math. Statist. 37, 1602-1630) and M. S. Srivastava (unpublished) connected with the asymptotic distribution of a sequential estimator for the regression coefficients in ANOVA and MANOVA. TAB

N68-26767# North Carolina Univ., Chapel Hill. Dept. of Statistics.

TABLES OF DISTRIBUTIONS OF QUADRATIC FORMS IN CENTRAL NORMAL VARIABLES 1

N. L. Johnson and Samuel Kotz (Temple Univ.) Dec. 1967 82 p refs *Its* Mimeo Ser. No. 543

(Grants NIH GMS-5R01GM-12868; AF-AFOSR-68-1415; AF-AFOSR-68-1411)

(AFOSR-68-0849; AD-668479)

The tables give values of the probability density and cumulative distribution functions of the random variable alpha sub 1 (U sub 1 squared) + alpha sub 2 (U sub 2 squared) + alpha sub 3 (U sub 3 squared) + alpha sub 4 (U sub 4 squared) where the Us are mutually independent unit normal variables, with the alphas satisfying the condition alpha sub 1 + alpha sub 2 + alpha sub 3 + alpha sub 4 = 4. The tables include sets of alpha values from (2.5, 0.7, 0.4, 0.4) to (1.1, 1.1, 0.9, 0.9) in all 36 sets of alpha values. The tabulated values shown to five decimal places are based on original calculations which should have an error less than 1 in the eighth decimal place. Author (TAB)

N68-26769# Naval Ordnance Lab., White Oak, Md.

A COMPUTER PROGRAM FOR THE NUMERICAL SOLUTION OF HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS BY THE METHOD OF CHARACTERISTICS

Jonathan Lee, Ralph Ferguson, and Theodore Orlow 31 Jan. 1968 35 p refs

(NOLTR-68-7; AD-668324)

A computer program is presented for solving a system of two quasilinear partial hyperbolic differential equations in two independent and two dependent variables by the method of characteristics. There is a discussion of the characteristic equations and the compatibility relations. The second order finite difference approximations to these are given along with a method to solve the difference equations. Author (TAB)

N68-26785# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.

ON TESTING A SET OF CORRELATION COEFFICIENTS FOR EQUALITY. 1: SOME ASYMPTOTIC RESULTS

Leon Jay Gleser Nov. 1967 15 p refs

(Contract Nonr-4010(09))

(TR-80; AD-668151)

Consider a random p-dimensional vector x having a multivariate normal distribution. We are interested in testing the hypothesis H that the correlations rho sub ij between the elements of x are equal to a common value rho (i not = j). The likelihood ratio test of H versus general alternatives is difficult to evaluate and complicated in form. Alternative tests have been proposed by Bartlett (J.R.S.S. Ser. B 16 296-298) by Lawley (Ann. Math. Statist. 34 149-151), and by Aitkin and Nelson (unpublished). The asymptotic null distributions of Bartletts and Lawleys tests have been obtained by Anderson (Ann. Math. Statist. 34 122-148) and Lawley (loc. cit.). The asymptotic null distribution of the Aitkin-Nelson test has not yet been obtained. The present paper obtains the asymptotic null distribution of the previously mentioned tests in a unified general fashion. Each of the above three tests is shown to be (under H) asymptotically equivalent to a member of a certain class of quadratic forms involving the sample correlations r sub ij. The asymptotic null distributions of such quadratic forms are obtained using the method of Lawley (loc. cit.). The null distribution of the Aitkin-Nelson test is found to be dependent upon rho (the parameter unspecified in the null hypothesis) in such a fashion as to suggest that the Aitkin-Nelson test is unpractical for most applications.

Author (TAB)

N68-26956# Carnegie-Mellon Univ., Pittsburgh, Pa. Management Sciences Research Group.

AN ALGORITHM FOR DIFFERENTIABLE CONVEX FUNCTIONAL PROGRAMMING WITH EXAMPLES AND APPLICATIONS TO LINEAR PROGRAMMING UNDER UNCERTAINTY

R. Jagannathan Aug. 1967 47 p refs

(Contract Nonr-760(24))

(RR-114; AD-668323)

The literature pertaining to linear programming under uncertainty is characterized by three major approaches, (i) Stochastic linear programming, (ii) chance constrained programming and (iii) Two-stage (in general m-stage) linear programming under uncertainty. These approaches offer a rich array of potential application possibilities provided algorithms can be made available to obtain solutions for any of the formulations that might be achieved. The present paper is directed to a study of some of the algorithmic possibilities with special reference to linear programming under uncertainty. More generally in Section 3 of this paper, a computational algorithm is developed for solving any convex programming problem with linear constraints when the criterion function has continuous derivatives. In Sections 4, 5, and 6 the applicability of the proposed procedure for solving a two-stage LP Model under three sets of assumptions regarding the stochastic nature of the defining parameters (A, B, c) is discussed. As illustrative examples, the capital budgeting and Portfolio Selection Models are considered in some detail. Author (TAB)

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N68-25816*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
INVESTIGATION OF WARM FOG PROPERTIES AND FOG MODIFICATION CONCEPTS
Warren C. Kocmond and James E. Jiusto Washington, D. C. NASA Jun. 1968 70 p refs
(Contract NASr-156)
(NASA-CR-1071; CAL-RM-1788-P-17) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Analytical and experimental investigations were conducted to examine the concept of modifying fog with hygroscopic material. The results indicate that it is possible to improve visibility in warm fog by seeding with micron-size salt particles (NaCl). The visibility in laboratory fog (produced in a 600 m^3 chamber) was increased by factors of three to ten, with as little as 1.7 mg of NaCl m^{-3} being effective. Only modest reductions (<1%) in ambient relative humidity were involved. Extrapolation of these results suggests that clearing a suitable landing zone for aircraft would not involve prohibitive amounts of seeding material. Recommendations are made for field testing the concept. Laboratory experiments also suggest that the formation of fog can be modified by seeding the atmosphere with salt nuclei prior to fog formation. While visibility improvements of a factor of two were achieved in the laboratory, the concept appears less practical for field use. An improved cloud nucleus chamber of the thermal gradient diffusion type was designed and is described together with results of a third year of observations. A "haze chamber" for measuring the concentrations of large and giant nuclei is discussed. Author

N68-25824# Joint Publications Research Service, Washington, D. C.
METEOROLOGY
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 181 6 Jun. 1968 p 11-63 refs Transl. into ENGLISH from various Russian articles (See N68-25822 15-13)

Meteorological news and scientific research from the Soviet bloc are reported, including news on weather forecasting, hydrological efforts, radio sounding, air pollution, and anemometers. Among the research articles are those dealing with cloud convection, wind variations, precipitation, optical radiation, and fog. Turbulence in boundary layers is reviewed, as are permafrost conditions in various areas, hygroscopic smoke, and temperature differences in the atmosphere. Artificial ice-forming aerosols, the atmosphere above the ocean, jet streams, and the accuracy of meteorological measurements are also considered. M.W.R.

N68-25845*# National Aeronautics and Space Administration, Washington, D. C.
EOLE-PACIFIC 4 FIELD EXERCISE, PART 1 [CAMPAGNE EOLE-PACIFIQUE 4 (IERE PARTIE)]
P. Morel et al May 1968 36 p Transl. into ENGLISH from Serv. d'Aeronomie, Centre Natl. de la Rech. Sci. (Verrieres, France), 25 Mar. 1968 49 p
(NASA-TT-F-11742) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Prospective scattering of groups of sounding balloons released simultaneously were studied in order to determine to what extent the trajectory of a single tracer is representative of the movement of that portion of the air in which it is carried. The balloons were released at the rate of four per hour from the Mildura, Australia meteorological station, whose median latitude location permitted placing the balloons in the midst of the general circulation from West. Also considered was the suitability of the inflatable frame Zodiac shelter for inflating and checking the tightness of the balloons. Preliminary data indicate that it is extremely difficult to accomplish a regular rhythm of releases, and that storage in a nonrigid shelter is not suitable for fragile and fatigue-sensitive balloon materials. M.G.J.

N68-26105# Air Weather Service, Scott AFB, Ill.
AN EVALUATION OF THE OPERATIONAL UTILITY OF DIRECT READOUT INFRARED SATELLITE DATA
Serhij Philipowskyj 27 Mar. 1968 21 p refs
(TR-199; AD-668125)

The study attempts to answer the question of the utility of direct-readout infrared data on the basis of data obtained from the Nimbus I and II spacecraft. Both spacecraft provided infrared data to a central readout station of the National Aeronautics and Space Administration. The high-resolution infrared data (HRIR) was recorded on 70mm film and is of photographic quality. The data sample is limited to September of 1964 and May thru November of 1966, the operating lifetimes of these infrared systems. A large number of HRIR pictures were available for this evaluation, as well as several DRIR data samples. The DRIR pictures were obtained from the Joint Typhoon Warning Center (JTWC) at Guam where a Navy APT set had been modified to receive DRIR data. Additional input into this study came from an evaluation of DRIR by the US Navy, from a large number of technical publications on this subject, and from personal contact with those who had worked with DRIR data. Author (TAB)

N68-26270# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
METEOROLOGICAL SHELL FOR STANDARD ARTILLERY PIECES. A FEASIBILITY STUDY
L. Edwin Williamson and Bruce Kennedy Oct. 1967 113 p refs
(ECOM-5161; AD-667914)

A feasibility study has been performed which considered the applicability of an instrumented shell for a standard rifled gun as a means of obtaining meteorological data for tactical Army applications. The conclusions have shown that the technical feasibility of a meteorological shell is within the state-of-the-art of engineering practices. Author (TAB)

N68-26306# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
METEOROLOGICAL REQUIREMENTS FOR THE AEROBEE-350
Edward M. D'arcy Jan. 1968 24 p refs
(ECOM-5172; AD-667921)

The report discusses the optimum wind layer thickness to be used for the Aerobee - 350. These layers should be small near the surface (close to the launcher) but can be relatively large at the top of the profile. The need for wind data above 100,000 feet is discussed. Results show that they are needed for the Aerobee - 350. The advisability of firing the Aerobee - 350 with a real-time met system is discussed and the conclusion reached that for best results, such a system should be used. Author (TAB)

N68-26450# Singco, Inc., Burlington, Mass.
RESEARCH STUDIES AND INVESTIGATION OF METEOROLOGICAL PHENOMENA Final Report, 13 Jan. 1965-14 Jan. 1968
Calvin Y. Sing, Anthony F. Souza, Edward N. Sabbagh, and Eileen T. Ahern 14 Apr. 1968 163 p refs
(Contract AF 19(628)-5029)
(AFCRL-68-0082; AD-669098)

Meteorological research and development in cloud physics and warm fog were performed in broad areas of instrumentation, field programs and data processing. The AFCRL Fog Research Site at Otis AFB, Falmouth, Mass., was instrumented, operated and

maintained in the summer months of 1965 as a part of Project Cat Feet. Case histories of warm fog were obtained with instruments including a laser disdrometer, liquid-water content meters, transmissometers wind sensors, nuclei counters, a micrometeorological tower, and atmospheric electricity meters. Instrumentation and equipment were designed, built and tested for both airborne and ground use. Extensive modifications were made to an airborne raindrop spectrometer and to a drop charge meter. A thermal gradient cloud-nuclei chamber was developed; a laser disdrometer system was devised for calibration of liquid water content meters in the Cloud Physics wind tunnel; ground field mills and equipment shelters were designed and built; sferics gear, temperature sensors and liquid-water content meters were tested and developed. Author (TAB)

N68-26468# Environmental Science Services Administration, Silver Spring, Md. Environmental Data Service.

PREDICTION OF MOVEMENT AND INTENSITY OF TROPICAL STORMS OVER THE INDIAN SEAS DURING THE OCTOBER TO DECEMBER SEASON

P. Jagannathan (World Meteorol. Organ.) and H. L. Crutcher May 1968 50 p refs

(EDS-4)

The wind and pressure fields relative to the storm center have been studied on the basis of storms which occurred in the Indian Seas during the period October to December, 1946–1960. The main aims were (1) to evolve a synoptic climatology of the storms, and (2) to evolve an objective technique for the prediction of position and intensity of the storm 24 hours ahead. Attention was concentrated on the pressure field at the surface and the wind and vorticity fields at the 500-mb level. Prediction equations for the central pressure, and the latitude and longitude of the center 24 hours in advance, have been obtained by screening a set of predictors. The variance explained by the equations is 37 percent for pressure, 21 percent for latitude, and 33 percent for longitude. For further reduction of variance one should look to other elements, e.g., sea surface temperature, wind and vorticity fields at other heights, the thermal field at other levels, and divergence. A prediction model which is somewhat superior to pure climatology has been provided. Author

N68-26576# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

A COMPUTER STUDY OF THE WIND FREQUENCY RESPONSE OF UNGUIDED ROCKETS

Edward M. d'Arcy Ft. Monmouth, N. J. Army Electron. Command Feb. 1968 29 p refs

(ECOM-5177; AD-667922)

The wind frequency response of several unguided rockets was studied using data collected by simultaneous releases of a jimsphere and a standard 100 gm balloon. Results show there can be large differences in the predicted rocket impacts using the two balloons. High wind frequencies are shown to affect the rocket only to a small degree and can be ignored in real-time rocket impact prediction applications. Averaging winds over a fifty-foot layer gives results comparable to the best Fourier smooth and binomial filter. Author (TAB)

N68-26580# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

REAL-TIME COMPUTATIONS OF PILOT BALLOON WINDS

Bernard F. Engebos and Louis D. Duncan Mar. 1968 25 p refs

(ECOM-5184; AD-667923)

The report shows that the mean wind through a given altitude layer can be determined from balloon tracking data without computing wind values for individual points within the altitude layer. The assumptions involved in the procedure are similar to the assumption made in numerical differentiating techniques, i.e., the position can be approximated by a polynomial. Two such techniques are investigated. One uses a linear equation to approximate the position; the other uses a cubic equation. These techniques were applied to balloon data from 27 balloon tracks and compared with results obtained from numerical differentiation. It is shown that there is very little difference among the results of the various calculation procedures. Author (TAB)

N68-26638# Travelers Research Center, Inc., Hartford, Conn.

BALLISTIC WINDS STUDY Quarterly Report, 1 Jun.–31 Aug. 1967

Frederick P. Ostby, Jr. Apr. 1968 27 p

(Contract DAAB07-67-C-0296)

(Rept.-7486-278; ECOM-0296-2; QR-2; AD-667912)

Space and time variability studies were conducted for the 12-rawin station mesonetwork of southeastern Arizona. The space variability studies showed that for low levels (below 1000 meters) there was only a slight increase in variability as a function of station separation. The root-mean square space difference of the vector wind (RMSSD) is 8.0 knots for stations within 20 km of each other, while the RMSSD is 9.6 knots for stations 120-140 km apart. At high levels (e.g., 8000 m) the variability difference with distance is sizeable. Investigations of time variability indicated the increase in variability with increasing time lag is less at low levels than at high levels. At low levels (around 1000 m) there is not much difference between a 2-hr old observation and one that is 8 hours old. At about 8,000 meters, the variability increased markedly with increasing time lag. From time variability profiles this is seen to be the level of maximum time variability for all lags with the variability diminishing rapidly with height thereafter. Author (TAB)

N68-26656 Michigan Univ., Ann Arbor.

ON MEAN MERIDIONAL CIRCULATIONS IN THE ATMOSPHERE

Anandu Devarao Vernekar (Ph.D. Thesis) 1966 166 p

Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-8358

The purpose of the study is to make a detailed investigation of mean meridional circulations forced by given eddy transports of heat and momentum and to describe the vertical variation of the energy conversions for the zonally averaged flow. A nonhomogeneous second-order partial differential equation for the vertical p-velocity, ω, is obtained from the quasi-geostrophic vorticity and thermodynamic equations. The diabatic heating in the meridional plane is estimated from the zonally averaged steady state thermodynamic equation. Computations of the zonal available potential energy and the conversion from zonal available potential energy to zonal kinetic energy are made using the distributions of diabatic heating, the vertical p-velocity and the temperature in the meridional plane. Dissert. Abstr.

N68-26704# Pennsylvania State Univ., University Park.

TRANSPORT AND DIFFUSION OF STRATOSPHERIC RADIOACTIVITY BASED ON SYNOPTIC HEMISPHERIC ANALYSES OF POTENTIAL VORTICITY, PART 3 Final Report

Edwin F. Danielsen Nov. 1967 97 p refs

(Contract AT(30-1)-3317)

(NYO-3317-3) CFSTI: HC $3.00/MF $0.65

Ertel's potential vorticity theorem is generalized to apply to bulk parcels which move with the mean or large-scale synoptic velocities. The mean velocities are obtained from the stream function which is derived by numerical solution of the balance equation on isentropic surfaces. Criteria for the solution were determined by hand analyses of vorticity and potential vorticity over the northern hemisphere above 20N. On the basis of the machine

analyses of potential vorticity and machine-computed isentropic trajectories the transport and diffusion of the potential vorticity are studied. Measurements of radioactivity are used to test the assumption that the potential vorticity in the lower stratosphere is positively correlated with stratospheric radioactivity, and that the changes in potential vorticity due to mixing should correspond to similar changes in the concentration of radioactivity. The results support the assumption; therefore the machine diagnostic and trajectory methods developed for this study are apparently sufficiently accurate to permit synoptic investigations of stratospheric radioactivity and ozone in terms of the distribution, movement, and destruction of potential vorticity. Author (NSA)

N68-28710*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.

INTERPRETATION OF ATMOSPHERIC EMISSION SPECTRA NEAR 1-CM WAVELENGTH

Hoo-min David Toong [1967] 11 p Presented at NEREM-67, Boston, 1–3 Nov. 1967

(Grant NsG-419)

(NASA-CR-87233) CFSTI: $3.00 CSCL 04B

Passive microwave meteorology techniques were used to measure atmospheric water vapor densities and cloud water content at 1 cm wavelength. Using a five-channel superheterodyne microwave radiometer fed from a single 20-db antenna, a complete spectral and meteorological history was recorded and charted on a cold front passing over the Boston area during the summer of 1966. To correlate experimental observations, a standard atmospheric model was postulated with temperature being modeled linearly with height, pressure, and water vapor density decaying exponentially with height. Figures are drawn to show the results of a comparison between theoretical and experimental emission spectra. B.S.D.

N68-28721# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.

USE OF THE AN/FPS-77 FOR QUANTITATIVE WEATHER RADAR MEASUREMENTS

Wilbur H. Paulsen Jan. 1968 14 p *Its* Instrumentation Papers No. 137

(AFCRL-68-0013; AD-668090)

A review is made of the assumptions that must be made in using a weather radar set for quantitative measurements of weather echoes. A simplified derivation is provided showing the relationship between the purely meteorological radar reflectivity factor Z and the radar received power for any weather radar set when the assumptions are fulfilled. A nomogram furnished for use with the AN/FPS-77 enables a simple conversion of receiver power to Z values. Author (TAB)

N68-28722# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

PRELIMINARY STUDY OF THE WIND FREQUENCY RESPONSE OF THE HONEST JOHN M50 TACTICAL ROCKET

Larry E. Traylor Mar. 1968 21 p refs

(ECOM-5183; AD-667910)

A study of the effect of various space frequencies of wind on the impact point of the Honest John M50 unguided tactical rocket is presented. The wind profiles were obtained from Fourier series fits to profiles obtained from Jimsphere balloons. High frequencies were truncated in successive steps to arrive at the effect of such frequencies on the impact point of the Honest John, as computed with a five-degree-of-freedom ballistic simulation model. Significant degradation of accuracy can occur when frequencies down to .001 cycle/ft are truncated. Author (TAB)

N68-26844* Weather Bureau, Houston, Tex. Spaceflight Meteorology Group.

MARINE CLIMATIC GUIDE

Houston, Tex. NASA. Manned Spacecraft Center Jan. 1968 116 p refs

(NASA-CR-95014) CFSTI: $3.00 CSCL 04B

Meteorological charts were prepared from the most recent information available in the U.S. Navy atlases; and, depending upon availability of data, the charts were analyzed on a monthly or seasonal basis. Values of the various parameters were selected to meet the requirements of NASA's Landing and Recovery Division. Limitations, arrangements, and interpretation are discussed for these marine climatic charts, which can be used most effectively to obtain first approximations. Charts depict monthly air temperature, sea surface temperature, surface wind speed, and visibility; and seasonal seas and superstructure icing. Monthly polar ice field is indicated on all of the charts. M.W.R.

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N68-25758# Royal Aircraft Establishment, Farnborough (England).

A REVIEW OF THE STABILITY AND CONTROL PROBLEMS OF MISSILES

W. M. Jarvis [1966] 30 p refs Presented at the AGARD Flight Mech. Panel Specialist Meeting on Stability and Control, Cambridge, Engl., 20–23 Sep. 1966

CFSTI: HC $3.00/MF $0.65

This paper discusses the particular problems of stability and control of guided missiles and draws comparisons with those which arise in aircraft autopilots. Particular attention is given to the very close interaction between the aerodynamics and the guidance system of certain types of missile and an example of this, the effects of radome aberration, is presented. The advantages and disadvantages of the most frequently used missile configurations are discussed. Finally an account is given of the stability and control problems of ballistic missiles and vehicles operating in vacuo, with emphasis on the effects of body flexure and aerodynamic instability. Author

N68-25930*# TRW Systems, Redondo Beach, Calif.

DESIGN CRITERIA FOR FLIGHT EVALUATION. MONOGRAPH 4: CONTROL SYSTEM EVALUATION

C. E. Sealander and L. Zamos 15 Mar. 1968 140 p refs

(Contract NAS8-20314)

(NASA-CR-95059; TRW-06671-6004-R000) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The flight evaluation of control systems for multistage launch vehicles is described with emphasis on the powered flight portion of the boost phase. The purpose and importance of control system flight evaluation is discussed along with the parameters which must be evaluated, and the limits and constraints involved in practical flight evaluation programs. The elements to be considered in planning a control system include (1) mission objectives, (2) control system design and characteristics, (3) flight test and ground support requirements, (4) trajectory influence and applicable flight events. The methods and analyses of a comprehensive flight evaluation program are described in detail. Techniques for control system evaluation are examined with respect to filtering, smoothing, transforming, derivation of computed sensor outputs, and simulation technique equations. B.S.D.

N68-26285# Aerospace Corp., El Segundo, Calif. Guidance Dynamics Dept.
A MODIFIED KALMAN FILTER FOR RADIO GUIDANCE APPLICATION
J. A. Henz Dec. 1967 131 p refs
(Contract F04695-67-C-0158)
(SAMSO-TR-68-155; TR-0158(3124)-1; AD-668447)

The modified Kalman filtering technique offers several distinct advantages over filters used previously in radio guidance equations. Presented are: a derivation of the Kalman filter; the filter force, measurement, and noise models; the transition matrix and coordinate transformation matrix derivations; a description of the modified filter equations; and results obtained from a computer program using the modified filter equations. Author (TAB)

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N68-25703# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART 1: COBALT-60 Quarterly Progress Report, Oct.–Dec. 1967
H. S. Hilborn, comp. Jan. 1968 12 p refs
(Contract AT(07-2)-1)
(DP-1143-1) CFSTI: HC$3.00/MF$0.65

Operation of capsules for ^{60}Co at 1000°C for one year will not be limited by diffusion of ^{60}Co in Hastelloy X, Hastelloy C, or Hanes 25, but may be limited by diffusion in Inconel 600 and TD Nickel. Several encapsulating alloys showed acceptable oxidation resistance at 1000°C in air for 9400 hr. Inconel 600 and Hastelloy X capsules that were heated in air at 1000°C for 5000 hr had no measureable dimension changes or leaks and predictably small oxidation and reactions layers. The capsules had 0.050-inch-thick walls and contained inactive cobalt wafers. A 0.050-inch-wall Inconel 600 capsule containing 15,000 curies of ^{60}Co as 150-curie/gram wafers had no measurable dimension changes or leaks after 5000 hr in air at ≈850°C. Destructive examination is in progress. Author (NSA)

N68-25715# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
ZERO POWER EXPERIMENTS WITH U^{235}-ENRICHED THORIA AND THORIUM METAL LATTICES FOR THE HWOCR
D. J. Pellarin, N. P. Baumann, J. L. Crandall, G. F. O'Neill, and R. M. Satterfield Nov. 1967 100 p refs
(Contract AT(07-2)-1)
(DP-1125) CFSTI: HC$3.00/MF$0.65

Lattice physics experiments were performed in the Process Development Pile (PDP) and the Subcritical Experiment (SE) to investigate thorium loadings for the Heavy Water Organic Cooled Reactor (HWOCR). The test fuel assemblies consisted of 85-rod clusters of THUD fuel, aluminum-clad rods of 0.234-inch UO_2–ThO_2 pellets with a $Th/^{235}U$ ratio of 49.03, and of coaxial U–Th metal tubes with approximately the same $Th/^{235}U$ ratio. These fuel assemblies were arranged into regular lattices at pitches of 9.0, 9.5, 10.5, and 12.12 inches in D_2O and tested with D_2O, air and Dowtherm A occupying the fuel coolant channels. Measurements included critical and exponential substitution buckling determinations and a variety of foil activations aimed at determining the subcadmium neutron distributions, the neutron temperatures, the cadmium ratios for ^{232}Th and ^{235}U, the ^{232}Th captures, and the $^{232}Th/^{235}U$ fission ratios. Author (NSA)

N68-25751# European Atomic Energy Community, Ispra (Italy).
ANALYSIS OF ACCIDENTS IN PULSED FAST REACTORS: COMPUTER PROGRAMMES DOPPELAS AND SOREX 1
J. Randles Brussels Apr. 1968 40 p refs
(EUR-3915.E) CFSTI: $3.00

Some of the main accident situations considered in the analysis of pulsed fast reactor safety are outlined and the accompanying physical conditions are discussed. It is suggested that accidents may be divided into four broad types while the nuclear excursions triggered by these accidents may be put into two classes depending on the magnitude of the fuel temperature rise. The class to which an excursion belongs determines the physical theory used to describe it, since the dominant reactivity feedback mechanisms will be different for a large than for a small temperature rise. The type of accident, on the other hand, determines only the form of the reactivity input. In this paper, two theories dealing with the two classes of nuclear excursion are sketched and two Fortran 4 computer programs based on these theories are explained in detail. The first, DOPPELAS, is designed to simulate the milder excursions in which the fuel retains its solid state. The second, SOREX 1, simulates the severe excursions which destroy the reactor explosively. Author

N68-25761# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
EUREX EURATOM-CNEN AGREEMENT ANNUAL REPORT, 1966 [CONVENZIONE EUREX EURATOM-C.N.E.N., RELAZIONE ANNUALE 1966]
Brussels EURATOM Apr. 1968 42 p refs In ITALIAN; ENGLISH summary
(Contract EURATOM-001-64-11 RCII)
(EUR-3901.I) CFSTI: HC$3.00/MF$0.65

This report relates to the second year of work in connection with the construction, operation, and use for industrial research purposes of the Eurex plant. The report treats: (a) design and construction of the plant; (b) laboratory and pilot scale tests and experiments prior to the start of plant operation; and (c) operation of the fuel element storage pool. Author

N68-25871# National Bureau of Standards, Washington, D. C.
ACTIVATION ANALYSIS. COCKCROFT-WALTON GENERATOR NUCLEAR REACTOR, LINAC, JULY 1966 THROUGH JUNE 1967
James R. de Voe, ed. Nov. 1967 91 p refs
(NBS-TN-428) GPO: HC$0.55; CFSTI: MF$0.65

The irradiation facilities of the nuclear reactor, Linac, and Cockcroft–Walton generator are described, and details are given on the construction of a clean room used for pre-irradiation chemical separation for high sensitivity activation analysis. Design, fabrication, and operational data are presented on special mechanical and electrical packages suitably interfaced to form one comprehensive activation analysis facility. These include a dual sample biaxial rotating 14 MeV neutron activation assembly, a pneumatic transfer system sequence programmer, a pneumatic transfer tube system, a highly sensitive photoelectric gas trigger, and a summing preamplifier. The high precision 14 MeV neutron activation analysis system was tested on a variety of standard reference materials (SRM) and other samples to investigate the major sources of systematic errors which directly affect accuracy. Particular attention is being directed to the analysis of macro concentrations (10% by weight). Efforts are also being made to monitor reactor neutron fluxes, and to evaluate the performance of the bremsstrahlung target used with the Linac. M.G.J.

N68-25892# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.
COMPARATIVE ANALYSIS OF GASEOUS NUCLEAR REACTORS FOR SPACE VEHICLE PROPULSION [VERGLEICHENDE ANALYSE VON GASKERN-REAKTOREN FUER ANTRIEBE VON RAUMFAHRZEUGEN]
Guenter W. Tumm 15 Jan. 1967 49 p refs In GERMAN
(TUB-IR-1/1967) CFSTI: HC $3.00/MF $0.65

Evaluated are plasma core, nuclear fission, and nuclear pulse reactor systems for their optimal propulsion performance in carrying 20,000 Mg payloads during 120 days. Cost estimates, mission flexibility, and production criteria are correlated with growth potential and the constructive sensitivity of the systems in regard to technological difficulties and internal disturbances. Calculations for Mars missions with an assumed payload of 20,000 Mg gave the capability factor for the three analyzed propulsion systems as: nuclear pulse: plasma core: nuclear fission core reactors = 6:3:1.
Transl. by G.G.

N68-25946# Mound Lab., Miamisburg, Ohio.
RADIOISOJET MICROTHRUSTER TEST Summary Report
E. W. Johnson and J. E. Glaub 20 Feb. 1968 22 p ref
(Contract AT(33-1)-GEN-53)
(MLM-1437) CFSTI: HC $3.00/MF $0.65

The promethium-147 radioisojet microthruster was tested during November, 1966. Two series of tests of the electrically heated microthruster were also performed, one test series before installation of the promethium-147 radioactive source. Constant temperature measurement tests and temperature recovery tests were performed with the promethium-147 capsule as the heat source. Core temperatures reached a maximum in excess of 1500°F.
Author (NSA)

N68-25977# United Kingdom Atomic Energy Authority, Risley (England). Health and Safety Branch.
HANDBOOK OF EXPERIMENTAL CRITICALITY DATA, PART 2
F. Abbey, comp. 1968 120 p refs
(AHSB/S/-Handbook-5, Pt. 2)

Experimental measurement data on single U^{235} cores moderated by hydrogen, and on single plutonium cores moderated by hydrogen, are compiled in table form for this handbook. Separate bibliographic references for each system to which each chapter refers are included.
G.G.

N68-26005# Technische Univ., Berlin (West Germany).
COMPARATIVE ANALYSIS OF GAS NUCLEAR REACTORS FOR THE PROPULSION OF SPACECRAFT [VERGLEICHENDE ANALYSE VON GASKERN-REAKTOREN FUER ANTRIEBE VON RAUMFAHRZEUGEN]
Guenter W. Tumm (Ph.D. Thesis) [1966] 222 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

The use of gas core nuclear reactors for coaxial flow and vortex flow propulsion systems is compared with solid core and pulsed reactor propulsion systems. Nuclear and propulsive aspects of these systems are investigated in depth, and a systems analysis is performed using representative assumptions to derive cost estimates. The significance of the principal parameters of the propulsion systems is discussed. It is shown that the vortex flow propulsion is preferable to the coaxial flow system and that the nuclear pulse system has advantages over the gas core system; however, gas propulsion is better suited for fast interplanetary flight than solid core propulsion.
Transl. by K.W.

N68-26039# Technische Univ., Berlin (West Germany).
MODEL STUDY OF FUEL REQUIREMENTS FOR FAST INTERPLANETARY FLIGHTS USING ADVANCED NUCLEAR PROPULSION SYSTEMS AND REFUELING AT DESTINATION [EINE MODELLUNTERSUCHUNG DES ERFORDERLICHEN AUFWANDES FUER SCHNELLE INTERPLANETARE FLUEGE BEI VERWENDUNG VON FORTSCHRITTLICHEN KERNENERGETISCHEN TRIEBWERKEN UND TREIBSTOFFERGAENZUNG AM ZIEL]
Guenter Marx (Ph.D. Thesis) [1967] 197 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

This volume contains the complete study of the subject, including the mathematical processes and details on trajectories, rockets, vehicle structures, environmental considerations, spacecraft protection, repair, maintenance, and costs. Mathematical models and graphics are used to determine the requirements for a fast interplanetary transport system to the planets Mercury and Jupiter. The calculations are based on the use of gas core reactor or nuclear pulse propulsive systems combined with refueling at the destination. Propulsive requirements for short flight times are determined by trajectory analyses, and statistical assumptions are made for vehicle mass in order to determine payloads. The interrelation of flight time and payload is examined. The flights of one interplanetary vehicle are complemented with short-haul ferry flights between the vehicle and Earth or the destination planet, thus expanding the flight to form a complete transport system. Specific transport costs were estimated for delivering a payload to the destination planet and returning it. Reusable vehicles are assumed throughout.
Transl. by K.W.

N68-26040 Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.
MODEL STUDY OF FUEL REQUIREMENTS FOR FAST INTERPLANETARY FLIGHTS USING ADVANCED NUCLEAR PROPULSION SYSTEMS AND REFUELING AT DESTINATION [EINE MODELLUNTERSUCHUNG DES ERFORDERLICHEN AUFWANDES FUER SCHNELLE INTERPLANETARE FLUEGE BEI VERWENDUNG VON FORTSCHRITTLICHEN KERNENERGETISCHEN TRIEBWERKEN UND TREIBSTOFFERGAENZUNG AM ZIEL]
Guenter Marx 15 Mar. 1967 66 p refs In GERMAN Short ed.
(TUB-IR-3/1967) CFSTI: HC $3.00

This version of the study outlines only the features and findings. Requirements for a fast interplanetary transport system to the planets Mercury and Jupiter are delineated in the form of mathematical models and graphics. The calculations were based on the use of gas core reactor or nuclear pulse propulsive systems combined with refueling at the destination. Propulsive requirements for short flight times were determined by trajectory analyses, and statistical assumptions were made for vehicle mass in order to determine payloads. The interrelation of flight time and payload is examined. The flights of one interplanetary vehicle are complemented with short-haul ferry flights between the vehicle and Earth or the destination planet, thus expanding the flight to form a complete transport system. Specific transport costs were estimated for delivering a payload to the destination planet and returning it. Reusable vehicles are assumed throughout.
Transl. by K.W.

N68-26114# Comitato Nazionale per l'Energia Nucleare Rome (Italy).
FRG—A PROGRAM FOR THE EVALUATION OF THE HOT SPOT FACTORS DUE TO FUEL ROD GEOMETRICAL DISHOMOGENEITIES [FRG—UN PROGRAMMA PER LA DETERMINAZIONE DEI FATTORI DI PUNTO CALDO CONSEGUENTI A DISOMOGENEITA GEOMETRICHE DELLA BARRA COMBUSTIBILE]
A. Cherubini 1967 25 p In ITALIAN; ENGLISH summary
(RT/ING(67)11) CFSTI: HC $3.00/MF $0.65

This program deals with the evaluation of the heat overfluxes transferred to coolant due to fuel pellet eccentricity or to cladding ovalness. Both these geometrical factors induce a circumferential variation on the fuel-cladding gap dimension, entailing a correspondent variation on its thermal conductance. The program determines the influence of such variation on the temperature and

heat flux distribution of fuel rods, with the aim of evaluating the hot channal factors or the hot spot factors which should be considered in the fuel rod thermal design. Author

N68-26178 Atomic Energy Commission Research Establishment, Riso (Denmark). Reactor Physics Dept.
HETEROGENEOUS REACTOR THEORY: 2 GROUP, 3 DIMENSIONAL THEORY FOR REFLECTED LATTICES
J. Pedersen 23 Oct. 1967 53 p refs
(RISO-M-645) CFSTI: $3.00

The theory for calculating the criticality condition of a three-dimensional, reflected heteorogeneous reactor lattice in $r-\theta-z$-geometry with the two group formalism is given. Three computer codes, HETPOL 3, SOUSI, and SOUSI 3 D R are briefly described. Author

N68-26357# Gulf General Atomic, San Diego, Calif.
BLOOST-6: A COMBINED REACTOR KINETICS–HEAT TRANSFER PROGRAM
M. H. Merrill 15 Dec. 1967 34 p refs
(Contract AT(04-3)-167)
(GA-8416) CFSTI: HC $3.00/MF $0.65

A complete description and listing of the BLOOST-6 computer program is given. BLOOST-6 is a combined reactor kinetics–heat transfer code written in FORTRAN-IV for the Univac-1108. The code is applicable only to problems for which the space-independent form of the reactor kinetics equation is valid. Subroutines used with the BLOOST-6 code are detailed; input data samples are shown. The required Univac-1108 starter deck is described. Initial conditions and running times are given; error stops are listed. A simplified flow diagram is shown. NSA

N68-26358# Gulf General Atomic, San Diego, Calif.
DESCRIPTION AND RESULTS OF THE P13G COATED PARTICLE IRRADIATION EXPERIMENT
C. S. Luby, A. S. Schwartz, and B. B. Spillane 9 Feb. 1968 33 p refs
(Contract AT(04-3)-167)
(GA-7549) CFSTI: HC $3.00/MF $0.65

Capsule P13G, in which several types of Buffer-Isotropic-coated carbide fuel particles were tested, was irradiated to estimated fuel burnups of 4% and 1% fissions per initial heavy metal atom (FIMA), for fissile and fertile particles, respectively, at estimated temperatures of 1250° to 1400°C. One cell reached an estimated temperature of 1250° to 1400°C. One cell reached an estimated 1900°C. The average temperature was 1350°C. Results of postirradiation examination indicate that: fissile particles show slight coating failure at low burnup (≈4% FIMA) when the ratio of coating thickness to particle diameter (T/D) is 0.33 but show no failure at $T/D \geq 0.38$, and fertile particles (T/D = 0.3) survived 1% burnup; and coated fissile (T/D = 0.5) and fertile (T/D = 0.3) particles irradiated to 4% and 1% burnup, respectively, survived at ≈1250 to 1400°C but experienced 25% failure at an estimated temperature of 1900°C. Author (NSA)

N68-26381# Brookhaven National Lab., Upton, N. Y.
POLLUTION-FREE HYBRID FOSSIL-NUCLEAR FUELED MHD POWER CYCLE
M. Steinberg, J. R. Powell, M. Beller, and B. Manowitz [1968] 51 p refs Presented at the Conf. on Intern. Energy Conversion Eng., Denver Sponsored by AEC
(BNL-12319; CONF-660837-1) CFSTI: HC $3.00/MF $0.65

A hybrid power plant is developed based on a hydrogen–oxygen combustion MHD cycle. Hydrogen is generated by reforming fossil fuel with nuclear generated steam and oxygen is obtained from air in an air separation plant. Steam is injected into the combustion gases to control temperature and pressure through the duct. A preliminary parametric study of the cycle efficiency and MHD characteristics is made with steam and helium as diluent. Overall thermal efficiencies of 55% appear practical with nuclear energy contributing 38% and coal 62% to the power cycle. The hybrid system allows the use of fossil fuel in a pollution-free plant; conventional water and gas-cooled nuclear reactors can be utilized in an MHD cycle; thermal pollution is significantly decreased; a clean MHD duct is provided. Author (NSA)

N68-26421# Argonne National Lab., Ill.
FUEL-ELEMENT LIFETIME
T. R. Bump [1967] 12 p refs
(ANL-RE-391) CFSTI: HC $3.00/MF $0.65

Problems in prediction of fuel element lifetime are discussed. Use of the SWELL computer code for lifetime calculations is described; results are shown graphically. The BULGE, CYCRO, and NUKER codes are described briefly. NSA

N68-26431# Los Alamos Scientific Lab., N. Mex.
THE PROPERTIES AND IRRADIATION BEHAVIOR OF CARBIDE FUELS: A LITERATURE SURVEY
Felix B. Litton 14 Mar. 1968 22 p refs
(Contract W-7405-ENG-26)
(LA-3799) CFSTI: HC $3.00/MF $0.65

No major deficiencies for fast reactor applications were found in the reported properties of carbide fuels. It appears probable that container compatibility problems can be reduced by using carbide compositions that are strictly stoichiometric, or buffered. Free metal in carbon-deficient fuel reacts with iron- or nickel-base containers to form low-melting alloys. In sodium-bonded configurations, carbon in excess of stoichiometric monocarbide is transferred to cladding materials that contain elements forming carbides more stable than the fuel carbide. No information was found on heat transfer or sodium stability in sodium-bonded fuel elements. Irradiation data indicate that fuel swelling depends on the carbon content, operating temperature, and burnup. Fuel swelling is a linear function of temperature to 1800°F, after which it is an exponential function. Fission gas release is related to the integrity of the fuel structure, the operating temperature, and burnup. The retention of fission gas appears to be satisfactory in mixed fuels up to about 50,000 MWd/t burnup. Strong containers that are stable to radiation effects will be required for burnups approaching 100,000 MWd/t. Author (NSA)

N68-26432# Los Alamos Scientific Lab., N. Mex.
CRITICALITY AND CENTRAL REACTIVITY CALCULATIONS USING ENDF/B DATA
R. J. LaBauve and M. E. Battat [1968] 7 p refs Presented at the 2d Conf. on Neutron Cross Sect. and Technol., Washington, D. C.
(Contract W-7405-ENG-36)
(LA-DC-9216; CONF-680307-23) CFSTI: HC $3.00/MF $0.65

A series of criticality calculations has been performed for selected experimental assemblies to test the Category I, ENDF/B neutron data. These assemblies include JEZEBEL (plutonium core), TOPSY (enriched uranium core with natural uranium reflector), and ZPR-3 Assembly 48 (plutonium fuel, soft spectrum). Central reactivity worths were also computed for several materials of interest in fast reactor design. In the course of obtaining multigroup constants for input to the Los Alamos Scientific Laboratory codes used in these calculations, several ENDF/B retrieval and processing codes were employed. These include DAMMET, a code for rearranging and altering the mode of the standard BCD ENDF/B library tape; ETOE, a code for preparing an MC^2 library tape; and MC^2, a code for generating multigroup constants from microscopic neutron data. Calculational results have been compared with experiment as well as results obtained using other nuclear data libraries. Author (NSA)

N68-26436# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
NITRIDE FUELS FOR FAST BREEDER REACTORS: FUEL CYCLE CONSIDERATIONS
J. E. Fletcher and J. Greenborg Feb. 1968 100 p refs
(Contract AT(45-1)-1830)
(BNWL-606) CFSTI: HC $3.00/MF $0.65

The nitrides of uranium and plutonium appear technically attractive as potential fuels for fast breeder reactors. To examine the potential economic status of the nitrides in commercial power production, a study was made to develop comparative fuel cycle costs for nitride and carbide fuels in a 1000 MW(e) sodium-cooled fast breeder reactor concept previously developed by Combustion Engineering, Incorporated. Results of the study indicate that nitrides would be competitive with carbides if low-cost processes for conversion of fuel materials to the nitrides were developed. The nitride fuels appear to contribute significantly toward a negative sodium-voiding coefficient. Author (NSA)

N68-26438# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
TESTS OF THE EFFECT OF SCALE BUILD-UP ON HEAT TRANSFER USING UNTREATED WATER UNDER CONDITIONS TYPICAL OF THE ETS-1 EXHAUST DUCT
D. R. Dickinson Mar. 1968 19 p ref
(Contract AT(45-1)-1830)
(BNWL-632) CFSTI: HC $3.00/MF $0.65

The possibility of scale formation in the coolant passages of the NERVA ETS-1 hydrogen exhaust duct was determined by tests conducted in an electrically heated test section representative of one of the flow passages, using well water from Jackass Flats, Nevada. Test conditions were: 1,352,000 Btu/hr ft^2 heat flux and 35 ft/sec water velocity for 243 min; 1,664,000 Btu/hr ft^2 and 35 ft/sec for 110 min; and 159,000 Btu/hr ft^2 and 3.5 ft/sec for 110 min. Little or no rise in wall temperature attributable to scale deposition was observed. Visual inspection at the end of the test showed a clean surface except for a light deposit at the upstream end. No corrosion of the stainless steel tubing occurred. At most, only a slight increase in surface temperature due to scale deposition will occur if untreated water is used to cool the ETS-1 exhaust duct, provided conditions are not more severe than in these tests. Author (NSA)

N68-26439# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
THE USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS Quarterly Report
Oct. 1967 59 p refs
(Contract EURATOM-001-61-1 TRUB)
(EURAEC-1937; QR-15) CFSTI: HC $3.00/MF $0.65

A new series of 35 fuel rods containing 2% ^{235}U and 2.7% Pu has been fabricated. Advantage was taken of the production of rods for the irradiations in boiling water capsules and in the hydraulic conveyor to perfect know-how in respect of plug welding and proportioning and densification problems. Provision was made for a second irradiation run in the EIR-WURenlingen (Switzerland) DIORIT reactor. Five fuel rods have been fabricated for it. A new UO_2 rod filling installation has been put into service; to handle 80 cm elements; it is being developed to take other dimensions. Bidistiller concentrate precipitation tests have been successfully carried out to revolve the problem of recovering the plutonium present in polymer form. The theoretical study of the effect of the longitudinal profile on the thermal performance of a core was continued by considering two axial power distribution profiles; a distribution with control rods partly inserted and a distribution with rods completely extracted. Results of the post-irradiation examinations carried out on the rods of the first boiling water capsule irradiation run (CEB-1) and those effected on the BR-3/PWR rods showed the beneficial effect of fuel heterogeneity on released fission gas recovery. The burnup ratios determined by radiochemistry on the rods of the CEB-1 and CEB-2 runs agree with the results obtained from the nickel cross temperature measurements. A fourth irradiation run in boiling water capsule was started. The maximum local power obtained was 600 W/cm. Results are given for the post-irradiation examinations carried out at Würenlingen on the plutoniferous rods irradiated in the DIORIT reactor. The maximum local calorific power is estimated as 700 W/cm, the maximum burnup ratio as 2,500 MWd/t. The 4 PANTHER code options to UO_2 and UO_2–PuO_2 lattices with different plutonium enrichments and isotopic compositions were applied. The critical cylindrical and rectangular configurations, with a single fuel area, were studied at SENA pitch multiplied by $\sqrt{2}$. The analysis of the data from the sub-critical tests on VENUS-Vulcain fuel has continued. The number and enrichment of the plutoniferous rods in the SENA core 7th tier sub-assemblies were determined from power distribution and two-dimension evolution calculations. Author (NSA)

N68-26455# Gulf General Atomic, San Diego, Calif.
THERMIONIC CRITICAL EXPERIMENT PROGRAM
S. C. Cohen 28 Nov. 1967 50 p refs
(Contract AT(04-3)-167)
(GA-8309) CFSTI: HC $3.00/MF $0.65

An examination of the unique features of a generic thermionic space power reactor and the related neutronic uncertainties and design problems are described. The overall objective of the critical experiment program is to compare integral neutronic data from a number of assemblies with detailed neutronic calculations in order to check analytical methods and cross section data used in the core design of thermionic space power reactors. This will be accomplished by constructing five categories of critical assemblies from the very simple in composition and configuration to the complex, culminating in a program of engineering mockup experiments. Author (NSA)

N68-26460# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
OXIDE FUEL IRRADIATION EXPERIENCE AT PACIFIC NORTHWEST LABORATORY
Stanley Goldsmith and M. D. Freshley 29 Jan. 1968 7 p Presented at the AEC-Industry Meeting on Water Reactor Fuel Elem. Technol., Washington, D. C., 29–30 Jan. 1968
(Contract AT(45-1)-1830)
(BNWL-SA-1624; CONF-680105-2) CFSTI: HC $3.00/MF $0.65

Fuel evaluations were performed representing grouping of various combinations of fuel materials and designs, and fabrication processes. Irradiations were performed using the Plutonium Recycle Test Reactor. At current power reactor operating conditions, vibrationally compacted UO_2–PuO_2 fuel was tested with excellent results. More severe operating conditions are proposed. NSA

N68-26461# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
SHORT-TERM DYNAMIC EFFECTS ON THE UTILIZATION OF PLUTONIUM AS A REACTOR FUEL
James R. Shoff Jul. 1967 53 p ref
(Contract AT(45-1)-1830)
(BNWL-475) CFSTI: HC $3.00/MF $0.65

Characteristic parameter studies on the BWR and PWR for two plutonium fuel enrichments are given. These parametric studies include effects of fuel element assembly size on initial excess multiplication factor for a graded fuel loading, delayed neutron fraction calculations, prompt neutron lifetime as a function of fuel exposure, prompt neutron decay constant calculations and effects on reactivity and Doppler coefficients. All calculated data are shown graphically. NSA

N68-26487# Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt.
IN-PILE DETERMINATION OF URANIUM DIOXIDE THERMAL CONDUCTIVITY, DENSITY EFFECTS, AND GAP CONDUCTANCE, 1964–1966
G. Kjaerheim and E. Rolstad Dec. 1967 85 p refs Sponsored in part by AEC
(HPR-80)

Fuel temperature measurements made in two instrumented fuel assemblies in the Halden Reactor are described. Effects of fuel density and gap between fuel and clad are determined. Burnup effects are evaluated also. Values for thermal conductivity are given. Radial clad strain is analysed. The mathematical model used for temperature calculations is described. NSA

N68-26505# Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt.
COMPILATION OF TEST FUEL DATA OF THE 1964–66 TEST FUEL PROGRAMME
K. D. Knudsen and E. B. M. Majoor Dec. 1967 128 p Sponsored in part by AEC
(HPR-81)

Thirty-eight fuel assemblies have been irradiated during the 1964–66 period in HBWR. The data of the various assemblies are compiled in this report. Author (NSA)

N68-26507# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
TWO LECTURES ON NUCLEAR REACTORS AND L. S. PONTRYAGIN'S MAXIMUM PRINCIPLE [DVE LEKTSII O YADERNYKH REAKTORAKH I PRINTSIPE MAKSIMUMA L. S. PONTRYAGINA]
A. P. Rudik 1967 60 p In RUSSIAN
(ITEF-539)

A method was developed on the basis of L. S. Pontryagin's maximum principle for optimizing the operating conditions, in order to solve reactor problems for cases, in which limiting conditions derived from constructional or heat-transfer considerations are applied. In order to carry out the optimization steps, an initial system of equations is formulated for $x^{(i)}$ determining the Hamiltonian and deriving an equation system for Ψ. All of the possible types of control are established for the Hamiltonian; a qualitative solution may be obtained only if the number of variables $x^{(i)}$ is small. The optimum solution may be determined by computer calculations. The method presents the advantage that it allows to determine conveniently the permissible types of control. If a neutron-pulse method is used, the correct position of the transducers must be determined by means of Pontryagin's maximum principle. NSA

N68-26553# Los Alamos Scientific Lab., N. Mex.
INTEGRAL TRANSFORM LIE SERIES ANALYSIS OF TRANSIENT TEMPERATURES IN REACTOR COOLANT CHANNELS
Roy Arthur Axford Sep. 1967 24 p ref
(Contract W-7405-ENG-36)
(LA-3833) CFSTI: HC $3.00/MF $0.65

A new method is developed for computing transient temperature fields in cylindrical reactor channels when the relative fuel power density, the coolant speed, and the channel inlet temperature are arbitrarily specified functions of time. Through the use of Hankel transforms, numerical instabilities inherent in finite difference approximations of spatial derivatives are avoided. Solutions of high order systems of ordinary differential equations in the time coordinate are efficiently obtained by a computational algorithm based upon the concept of Lie series. Author (NSA)

N68-26589# Battelle Memorial Inst., Columbus, Ohio.
FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS Quarterly Progress Report, Oct.–Dec. 1967
Joseph M. Genco, Harvey S. Rosenberg, David A. Berry, Warren E. Berry, George E. Cremeans et al 1 Jan. 1968 42 p
(Contract W-7405-ENG-92)
(BMI-X-10222; EURAEC-1994) CFSTI: HC $3.00/MF $0.65

Results of measurements of hydrogen iodide (HI) deposition on stainless steels are shown graphically; data are tabulated. Effects of geometry on deposit-surfaces are considered. Effects of pressure and temperature on elemental iodine deposition on painted surfaces are determined; data are tabulated according to surface. Liquid-phase deposition of iodine and tellurium ions under containment systems conditions is measured. Deposition data are applied to postulated reactor accidents. Effects of use of containment spray systems on containment system coatings are analyzed. Data are presented on adhesives for bonding asbestos to steel. NSA

N68-26673# Oak Ridge National Lab., Tenn.
IN-REACTOR AND POSTIRRADIATION CREEP-RUPTURE PROPERTIES OF TYPE 304 STAINLESS STEEL AT 650°C
E. E. Bloom Mar. 1968 23 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2130) CFSTI: HC $3.00/MF $0.65

The creep-rupture properties of type 304 stainless steel have been determined in the unirradiated condition and for specimens tested both during and after irradiation. Tests were performed at 650°C at stresses between 15,000 and 30,000 psi. Creep rates for irradiated specimens tested by both in-reactor and postirradiation were approximately the same and consistently higher than those of the unirradiated alloy. The higher creep rates for the irradiated specimens were due to grain-boundary fracture while the material was still in the primary stage of creep. Both ductility and rupture life were reduced by irradiation. Metallographic observations suggest that in an irradiated specimen grain-boundary fracture is initiated by the linking of grain-boundary voids. The stress-induced growth of helium bubbles will account for these observations. Author (NSA)

N68-26684# Battelle Memorial Inst., Columbus, Ohio.
ECCSA-1: A DIGITAL COMPUTER PROGRAM FOR THERMAL AND HYDRAULIC ANALYSIS OF CORE CHANNELS IN THE EVENT OF A NUCLEAR-REACTOR LOSS-OF-COOLANT ACCIDENT
Jay S. Iyer 1 Apr. 1968 79 p refs
(Contract W-7405-ENG-92)
(BMI-1832) CFSTI: HC $3.00/MF $0.65

ECCSA-I is a digital computer program specifically designed to predict the thermal and hydraulic performance of reactor core channels during a loss-of-coolant accident and subsequent emergency core cooling injection. The program represents reactor fuel rods and associated flow channels by means of an equivalent single channel. Thermal and hydraulic behavior in the channel is predicted on a local basis at various axial positions during the blowdown, core heat-up, and emergency core cooling injection phases of an accident. Blowdown pressure and flow information are used as input data for ECCSA-I. The development and content of the program is described, including major assumptions, mathematical models, and computer equations. A source deck and sample problem for the CDC-6400 computer will be available through the ANL Code Center. Typical results are presented for analyses of BWR, PWR, and LOFT loss-of-coolant accidents. Author (NSA)

N68-26685# Atomic Power Development Associates, Inc., Detroit, Mich.
PERMANENT MAGNET-TYPE FLOWMETERS AND THEIR APPLICATION IN THE ENRICO FERMI ATOMIC POWER PLANT

Michael A. Ziniuk, Clyde C. Scott, and Toshio Meshii Mar. 1968 90 p refs
(Contract AT(11-1)-865)
(APDA-304) CFSTI: HC $3.00/MF $0.65

Stabilized precision magnetic flowmeters used in liquid-metal systems of reactors are defined with respect to design requirements, materials, fabrication practices, and calibration procedures. Analytical review of magnetic flowmeter theory is included to a limited extent. Discussion of the material aspects of magnets for flowmeters is limited to three widely used grades of Alnico since it has the desired properties. In 1956, when a decision was made to install permanent magnet-type flowmeters in the primary sodium system of the Enrico Fermi plant reactor, there was available only a limited amount of experience relative to flowmeters in liquid-metal systems. Several years after the primary system flowmeters were installed in the Fermi plant, calibration tests were attempted, with the use of data from the primary sodium pumps. The resulting experimental calibration curves revealed nonlinear relationships whereas the vendor's calibration curves were linear with respect to flow. The nonlinearities in the Fermi flowmeters were the result of the 0.7 ratio (approximate) of pole face length to pipe diameter for the 14-inch flowmeters. Conversely, the permanent magnet-type flowmeters of the secondary system had linear outputs with a 3.0 (approximate) ratio of pole face length to pipe diameter.
Author (NSA)

N68-26693# Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering.
RESEARCH AND EDUCATIONAL ACTIVITIES AT THE MIT REACTOR TO AND INCLUDING FISCAL YEAR 1967, 1 JULY 1966–30 JUNE 1967
Dec. 1967 134 p refs
(Contract AT(30-1)-1967)
(MITNE-91; MIT-1967-1) CFSTI: HC $3.00/MF $0.65

A report of research and educational activities which utilized the Massachusetts Institute of Technology, five-megawatt, heavy water, research reactor during fiscal year 1967 has been prepared for administrative use at MIT and for presentation of the U. S. Atomic Energy Commission. The latter action is required by Contract AT(30-1)-1967 under which the AEC provides the fully enriched uranium-235 fuel and the heavy-water moderator-coolant for the reactor. Research projects at MIT which make significant use of the MITR are described, and principal participating personnel are named. Listings are provided of theses, reports, journal articles, and conference papers resulting from these projects during fiscal year 1967. In addition, since no comprehensive bibliography of these publications has previously been issued, the report lists essentially all documents of these types which are concerned with the design, operation, or research use of the MITR since its construction was first contemplated at the Institute. In addition to the educational value derived from the many research activities by the students who participate in them, training in several areas of nuclear technology is imparted through formal courses designed to make use of the reactor or its research projects. The courses are briefly described, and attendance figures are given. Detailed information concerning the research activities of the numerous other universities, hospitals, and commercial companies which have used the MITR for irradiations is not available, but these organizations and also the materials irradiated are listed. The reactor, its purpose, its organization, and a summary of operations are briefly described in order to provide a more complete understanding of the MITR program.
Author (NSA)

N68-26717# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
PRELIMINARY RELIABILITY ANALYSIS FOR FFTF SAFETY CIRCUITS
Oscar B. Monteith Mar. 1968 29 p refs
(Contract AT(45-1)-1830)
(BNWL-661) CFSTI: HC $3.00/MF $0.65

A preliminary reliability prediction for the Fast Flux Test Facility Reactor Safety System is reported. The system is analyzed for two failure modes: failures that cause spurious responses (reactor scrams), and failures that result in the inability to respond to unsafe conditions. Results are preliminary because the system is a conceptual version and components have not been specified.
Author (NSA)

N68-26731# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
ADSORPTION OF KRYPTON AND XENON FROM ARGON BY ACTIVATED CHARCOAL
D. A. Collins, R. Taylor, and L. R. Taylor 20 Sep. 1967 20 p refs
(TRG-1578) CFSTI: HC $3.00/MF $0.65

In sodium-cooled fast reactors the argon cover gas may require purification from radioactive krypton and xenon. Coconut-based charcoals were found to be superior to other types for the adsorption of krypton and xenon from argon. Adsorption coefficients for xenon and krypton were measured over a wide range of concentrations in argon, and the effect of coadsorption of krypton on the adsorption coefficients for xenon was examined. The effect was not serious at temperatures down to −70°C if the krypton concentration in the gas phase was below 1000 vpM.
Author (NSA)

N68-26750# General Electric Co., Sunnyvale, Calif. Advanced Products Operations.
EVALUATION OF THE EFFECT OF DESIGN AND OPERATING VARIABLES ON SEFOR FUEL AND FUEL CLADDING
J. H. Field, M. L. Johnson, and P. E. Novak Dec. 1967 72 p refs
(Contract AT(04-3)-540)
(GEAP-5309) CFSTI: HC $3.00/MF $0.65

Fourteen capsule experiments were irradiation-tested to investigate design parameters and expected operating conditions on SEFOR fuel. Irradiation tests of SEFOR fuel with reference design cladding thickness and fuel-cladding gaps subjected to expected steady-state and power oscillation conditions resulted in no cladding distortion. Similar specimens subjected to TREAT transients to near fuel melting experienced minor cladding ridges at the fuel pellet interfaces. Cladding maintained its integrity during all tests including non-standard conditions of operation above melting of fuel, reduced fuel-cladding gaps, and sodium ingress into the fuel prior to transient.
Author (NSA)

N68-26764*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
METHOD FOR CALCULATING ALLOWABLE CREEP STRESS IN LINEARLY INCREASING STRESS ENVIRONMENT
Charles L. Whitmarsh, Jr. Washington Jan. 1968 12 p refs
(NASA-TN-D-4352) CFSTI: HC $3.00/MF $0.65 CSCL 18J

An analytical technique was developed to calculate the allowable design stress for a specified creep limit of a material under conditions of linear stress buildup and constant temperature. The analysis utilizes constant-stress creep data in the integration of a stress-dependent creep rate over the material history. Allowable design stress limits for 1-percent creep of refractory metals in the temperature range 800° to 1600°K are increased by 25 to 57 percent when compared with calculations based on the constant end-of-life stress conditions.
Author

N68-26793# United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch.
HANDBOOK OF EXPERIMENTAL CRITICALITY DATA. PART 1—CHAPTERS 1 TO 4
F. Abbey, comp. 1967 122 p refs
(AHSB/S/-Handbook-5, Pt. 1) CFSTI: $3.00/MF $0.65

Criticality data from the literature are compiled into tabulated form. These tables are broken down into: single unmoderated ^{235}U cores; single unmoderated plutonium cores; single ^{235}U cores moderated by deuterium, beryllium, or carbon; and single plutonium cores moderated by deuterium, beryllium, or carbon. Data are given various geometric configurations. NSA

N68-26798# Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.
URANIUM PLUTONIUM CARBIDE DEVELOPMENT Quarterly Progress Report, for Period Ending Dec. 31, 1967
A. Biancheria, E. C. Bishop, and W. R. Jacoby Jan. 1968 107 p refs
(Contract AT(30-1)-3791)
(WARD-3791-12) CFSTI: HC $3.00/MF $0.65

The production of fuel pellets for GETR Phase I irradiation test capsules was initiated and continued. Process and equipment problems have delayed the completion of the three capsules; however, sufficient unmodified and chromium-modified pellets for the first of the three capsules and most of the pellets for the other two capsules were manufactured. A limited investigation on process variables was conducted. The three pins for the first GETR irradiation test capsule were fabricated. Work progressed on EBR-II irradiation specimen fabrication. Two fuel pin specimens and five vanadium containers were bonded and evaluated, and modifications to the sodium glovebox for the handling of the 40-inch long capsule were completed. A program was started and completed during the period to provide data to indicate an optimum process for bonding of GETR irradiation pins. Because sufficient space was not available in the glovebox used for sodium bonding development, test apparatus for sodium deposition studies were modified to make the apparatus self-contained. NSA

N68-26799# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
CRACK HEALING AND VOID MOVEMENT DURING IRRADIATION OF THORIUM OXIDE-2 WEIGHT PERCENT URANIUM DIOXIDE
A. S. Bain May 1967 30 p refs
(AECL-3008) CFSTI: HC $3.00/MF $0.65

Zircaloy-2 sheathed ThO_2–2 wt% UO_2 pellets, which had preformed cracks and holes, were irradiated for 69 days at a power rating of $\int \lambda d\theta$ = 61 W/cm. Central temperatures were 2400° ± 200°C, based on an estimated λ = 0.031 W/cm°C. Where circumferential crack widths had been large the diametral expansion of the sheath was low, indicating that the hot fuel was plastic and could move into the voidage. Cracks and axial holes were eliminated above an estimated temperature of 1700 ± 150°C, compared with 1400 ± 100°C for UO_2; both temperatures are 0.55 of the absolute melting point. There was no sublimation across any crack; other possible crack healing mechanisms, e.g., creep, surface diffusion, grain boundary sliding have been considered. Compared with UO_2 irradiated at the same power per unit length, the thoria fuel had less diametral expansion, less grain growth; autoradiographs showed essentially no fission product relocation. The presence of a circumferential crack near the periphery throughout the irradiation did not significantly impede heat transfer. Author

N68-26833# Bettis Atomic Power Lab., Pittsburgh, Pa.
ELASTIC ANALYSIS OF THERMAL GRADIENT BOWING IN ROD-TYPE FUEL ELEMENTS SUBJECTED TO AXIAL THRUST (LWBR/LSBR DEVELOPMENT PROGRAM)
John B. Newman Jan. 1968 87 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-728) CFSTI: HC $3.00/MF $0.65

Thermal gradient bowing of rod type fuel elements can be analyzed in terms of the deflections of a precurved beam. The fundamental aspects of an analysis of axially compressed multispan beams are given. Elasticity of supports in both axial and transverse directions is considered; the technique is applicable to problems in which the axial thrust depends on the transverse deflection as well as problems with prescribed axial thrust. The formulas presented constitute the theory for a computer program of broad applicability, not only in the analysis of fuel rod bowing, but also to almost any multispan beam, particularly when the effects of axial loads cannot be neglected. Author (NSA)

N68-26834# Bettis Atomic Power Lab., Pittsburgh, Pa.
USE OF THE COMPUTER IN CRITICALITY STUDIES
L. L. Jones, Jr. Feb. 1968 25 p refs Presented at the Seminar on Nucl. Criticality Safety, Pittsburgh, 25 Mar. 1968
(Contract AT(11-1)-GEN-14)
(WAPD-T-2122; CONF-680312-1) CFSTI: HC $3.00/MF $0.65

The use of neutron diffusion and transport theory computer programs to determine criticality control parameters for nuclear reactors and fuel processing and handling is discussed. Three examples of the application of computer programs for criticality studies include: one and two-dimensional diffusion theory programs; and a three-dimensional MONTE CARLO program. NSA

N68-26835# Portugal. Nuclear Energy Commission, Sacavem. Lab. of Physics and Nuclear Energy.
POISONING BY THE RPI FISSION PRODUCTS Xe-135 AND Sm-149 [ENVENEMENTO DO RPI PELOS PRODUTOS DE CISAO Xe-135 E Sm-149]
E. Martinho 1968 30 p refs In PORTUGUESE
(LFEN-N1.34 α) CFSTI: HC $3.00/MF $0.65

A mathematical discussion of the accumulation of fission products from direct and indirect fission in a nuclear reactor fuel is presented. These products are identified as the primary cause of decrease in radioactivity in the nuclear reactor core. Among these nuclei, Xe 135 and Sm 149 are the principle causes for the decay. Transl. by F.S.

N68-26838*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
NUCLEAR BRAYTON CYCLE POWERPLANTS FOR SPACE APPLICATIONS
Steven I. Freedman, J. T. Keiser, R. M. Cohen, and W. R. Terrill 17 Aug. 1967 47 p refs Presented at the 2d Ann. Intersoc. Energy Conversion Eng. Conf., 13–17 Aug. 1967
(Contract NASw-980)
(NASA-CR-89172; Doc.-6300-230) CFSTI: HC $3.00/MF $0.65
CSCL 18E

A parametric analysis and system optimization was made of reactor heated Brayton cycle space powerplants in the 50 to 200 KWe range. Turbomachinery performance was based on the efficiencies of the NASA/Lewis two-shaft solar Brayton cycle system, and on a growth machine at a lower pressure level. Dependence of optimized system specific weight on turbine inlet temperature and power rating was determined. In order to determine the effects of reactor shielding requirements on powerplant weights, two types of applications were considered, an unmanned mission requiring shadow shielding, and a manned space station application in which sculptured wrap around shielding was needed. Emphasis was placed on the nuclear reactor heat source, the radiator, and powerplant arrangements as they are influenced by spacecraft integration requirements. Parametric evaluation was made of various system configurations, including single-, two-, and three-loop arrangements with different combinations of liquid and gas cooled reactors and radiators. Parametric models of all major powerplant subsystems, gas and liquid-metal cooled reactors, shields, turbomachinery, heat exchangers, gas ducting, and gas and liquid-metal filled radiators were synthesized. Author

N68-26868# California Univ., Livermore. Lawrence Radiation Lab.
IRRADIATION EFFECTS IN BeO AND COMPARISON OF BeO AND MgO AS POTENTIAL REFLECTOR MATERIALS

Gurnam Sidhu 21 Dec. 1967 17 p refs *Its* Space Power Note No. 265
(Contract W-7405-ENG-48)
(UCID-15285) CFSTI: HC $3.00/MF $0.65

Possible changes in the essential properties of BeO reflector material were studied in a radiation environment. Volume increase, migration and agglomeration of transmutation products (such as helium), defect clusters, microcracking, changes in elastic constants, and strength are discussed. Methods of minimizing radiation damage and possible use of MgO as a reflector are suggested. NSA

N68-26860# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
OUTSIDE CELL SIMULABILITY OF THE OBSTRUCTION PHENOMENON OF A BLANKET OF FUEL OPEN TO THE COOLANT [SIMULABILITA FUORI PILA DEL FENOMENO DI INTASAMENTO DEL MANTELLO DI UN COMBUSTIBILE APERTO AL REFRIGERANTE]
G. J. Segre and S. Sartori 1968 177 p refs In ITALIAN; ENGLISH summary
(RT/ING(68)4) CFSTI: HC $3.00/MF $0.65

The studies carried out in order to clarify the problems related to the flow of fission products through a blanket of a fuel open to the coolant, are reported. From a series of investigations for each phenomenon and from an effort of separation of the most suitable model, a programme of experiments has been derived. Author

N68-26942# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES Quarterly Report, Oct.–Dec. 1967
Mar. 1968 108 p refs
(Contract AT(45-1)-1830)
(BNWL-685) CFSTI: HC $3.00/MF $0.65

Progress is reported in activities concerning the following: (1) fuel element, control, and reactivity characteristics for Plutonium Recycle Test Reactor and Critical Facility; (2) fuel element and burnup data for Experimental Boiling Water Reactor; (3) core variations, reactivity, and neutron flux in Physical Constants Testing Reactor; (4) criticality and neutron measurements in Critical Approach Facility; (5) startup and control of High Temperature Lattice Test Reactor; (6) core, neutron, control, and reactivity calculations for Fast Test Reactor; (7) shielding requirements for Fast Flux Test Facility; and (8) neutron scattering and dynamics in water. K.W.

N68-26947# Minnesota Mining and Mfg. Co., St. Paul, Minn.
SNAP-21 PROGRAM. PHASE 2: DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM Quarterly Report, Oct. 1–Dec. 31, 1967
F. Fox 31 Dec. 1967 178 p
(Contract AT(30-1)-3691)
(MMM-3691-26; QR-6) CFSTI: HC $3.00/MF $0.65

Work progress is reported for numerous activities of the SNAP 21 program, including: (1) completion of a computer program for analyzing thermal characteristics; (2) design and inspection of the biological shielding system, in which plasma sprayed aluminum oxide is used as the compatible barrier material; (3) assembly, instrumentation, and thermal performance testing of insulation systems and shipping containers; (4) dynamic testing of redesigned segmented retaining ring; (5) design and testing of pressure vessels; and (6) design, assembly, processing, and testing of thermoelectric generators and components. K.W.

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N68-25661# Los Alamos Scientific Lab., N. Mex.
STABILITY OF THE NEW RADIO FLASH CODE
R. D. Richtmyer (Colo. Univ., Boulder) Aug. 1967 15 p refs
(Contract W-7405-ENG-36)
(LA-3864-MS) CFSTI: HC $3.00/MF $0.65

An analysis was made of the Radio Flash Code for calculating the radio emission from underground and atmospheric explosions. NSA

N68-25705# California Univ., Livermore. Lawrence Radiation Lab.
COMPENDIUM OF SHOCK WAVE DATA
M. van Thiel, ed., A. S. Kusubov, ed., and A. C. Mitchell, ed. Oct. 1967 524 p refs
(Contract W-7405-ENG-48)
(UCRL-50108, V. 1, Sup. 1) CFSTI: HC $3.00/MF $0.65

New and corrected pages on thermodynamic data in condensed media obtained by shock wave techniques are given for inclusion in the original publication which was abstracted in NSA 21: 5848. Indexes are included. NSA

N68-25725# Laboratoire de Physique Theorique et des Hautes Energies, Nice (France).
NON-SATURATION OF GRAVITATIONAL FORCES
Jean-Marc Levy-Leblond Feb. 1968 17 p refs
(NTH-68/2) CFSTI: HC $3.00/MF $0.65

Rigorous inequalities are derived for the ground-state energy of a non-relativistic quantum-mechanical system of N particles in gravitational interaction. It is shown that gravitational forces do not saturate like N^2 for a Bose system and like $N^{4/3}$ for a Fermi system. A a by product a generally valid Heisenberg-like inequality for N-fermion systems results, expressing very simply the effect of the Pauli exclusion principle. These results are extended to a system of oppositely charged particles behaving with respect to gravitational forces, as a Fermi system as soon as particles with one sign of charge only are identical fermions. This explains quantitatively how and when gravitational forces finally dominate Coulomb forces for large enough bodies (planets). A further extension to the case where relativistic effects enter only at the kinematical level yields the existence of the Chandrasekhar mass limit, above which no collection of cold matter is stable (white dwarf stars). Author

N68-25729* Techtran Corp., Glen Burnie, Md.
LIGHT AS A CARRIER OF INFORMATION [SVET KAK NOSITEL' INFORMATSII]
I. A. Deryugin Washington NASA May 1968 36 p refs Transl into ENGLISH from the Publ "Kvantovaya Elektronika" Kiev, Naukova Dumka Press, 1967 p 185–214
(Contract NASw-1695)
(NASA-TT-F-11743) CFSTI: $3.00 CSCL 20F

A theoretical examination of certain physical properties of the photon field which determine its usefulness as a carrier of information is presented. The theory of photon coherence is analyzed, together with the correlation between the fluctuations of photon field oscillators. The quantum theory of coherence and correlation is described, and the coherent properties of laser emissions are analyzed on the basis of scalar correlation functions. Attention is

turned to polarization, correlation radius, and the degenerate state of photons. The statistics of laser emission are examined, including the effects of noise, temperature and radiation entropy. Author

N68-25765*# Techtran Corp., Glen Burnie, Md.
CALCULATION OF EFFICIENCY AND FREQUENCY CHARACTERISTICS OF CYCLOTRON GENERATORS OPERATING AT HARMONICS OF THE GYROFREQUENCY [RASCHETY K. P. D. I CHASTOTNYKH KHARAKTERISTIK TSIKLOTRONNYKH GENERATOROV NA GARMONIKAKH GIROCHASTOTY]
G. N. Rapoport, V. A. Zhurakhovskiy, S. V. Koshevaya, and T. A. Gryaznova Washington NASA May 1968 11 p refs Transl. into ENGLISH from Izv. Vuzov. SSSR, Ser. Radioelektron. (USSR), v. 10, no. 11, 1967 p 996–1002
(Contract NASw-1695)
(NASA-TT-F-11731) CFSTI: $3.00 CSCL 20G

Based on nonlinear theory, the amplitude and phase balance of a cyclotron and generator with a helical electron beam in a hollow or open resonator is analyzed. The efficiency of the generator at the first and second harmonics of the cyclotron frequency is investigated as a function of the ratio of working current to starting current and the detuning of the cyclotron frequency of the magnetic field from the natural frequency of the resonator. The results of calculations allow an estimation of the optimal generator parameters for provision of the maximum efficiency and the demands placed on its elements from the point of view of stability of the frequency. Author

N68-25789*# Naval Academy, Annapolis, Md.
SPATIAL LIGHT MODULATION EMPLOYING A FERRO-MAGNETIC FLUID
J. P. Uldrick and P. A. Lux (Sacramento State Coll.) *In* NASA. Goddard Space Flight Center The ASEE-Univ. of Md.-Catholic Univ.-NASA Summer Fac. Fellowship Program Apr. 1968 p 185–214 refs (See N68-25779 14-07)

Consideration is given to the feasibility of synthesizing a fluid light modulator by using a ferromagnetic fluid for transducing an electrical signal into a corresponding spatial transparency distribution. Several cells using 3" × 5" glass plates with 0.01" to 0.10" spacings were constructed. A clear fluid was passed through the region between the plates at about 1 foot per second. In the middle of the stream a small stream of opaque fluid was inserted in the clear carrier fluid to form a pattern between the plates. Since the flow is laminar the pattern holds its shape as it traverses the cell. The storage time is adjusted by regulating the flow rate of the clear carrier fluid. A ferromagnetic fluid was manufactured for use as the opaque fluid. Since this fluid is highly responsive to magnetic fields, it is possible to deflect it with an electromagnet. This gives a method for transducing an electric signal into an optical pattern. By properly shaping the poles of the electromagnet it is possible to exert a constant body force on the ferrofluid in some region between the poles. The ferrofluid consists of Fe_3O_4 particles of about 100 antroms in diameter suspended in JP-4 jet fuel. Author

N68-25868*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OPTICALLY INDUCED FREE-CARRIER LIGHT MODULATOR
C. Gruber and W. E. Richards Washington Jun. 1968 18 p refs
(NASA-TN-D-4608) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Laser modulators for optical communications systems have recently been the subject of great effort especially in visible or near-infrared regions. The availability of optical sources in these regions, where excellent atmospheric transmission "windows" exist, has prompted attempts to extend the previously developed modulation techniques to longer wavelengths. Existing devices have other disadvantages such as excessive drive power requirements for high-frequency/wide-bandwidth operation, multicomponent optical configurations, inability to modulate at high optical power levels, and (with one or two exceptions) low modulation index. The present paper describes an optical modulation technique that should be able to overcome many of these difficulties and, in addition, provide complete electrical isolation of the modulation element. In addition the technique can be used over a broad range of infrared wavelengths determined solely by the optical transmission characteristics of the modulator material. In brief, this technique uses optically generated free electrons (and/or holes) in a bulk semiconductor in order to change its transmission characteristics. Apart from its construction in suitable semiconducting material, the modulator requires an easily modulated optical pump signal. Author

N68-25904 Arkansas Univ., Fayetteville.
X-RAY DIFFRACTION STUDY OF ARGON AND XENON IN THE LIQUID-STATE
Ronald Wilbert Harris (Ph.D. Thesis) 1967 151 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-8725

X-ray diffraction patterns obtained from liquid argon and liquid xenon in equilibrium with their vapors at a temperature 0.3 K° from the triple points of both liquids and 3.2 K° from the triple point of argon, were used to calculate the corresponding radial distribution functions and distribution functions. Isothermal compressibilities, potentials of the mean force, and the mean-square variations of the distance between nearest neighbors were calculated from these functions. The number of nearest neighbors was determined on the basis of ideal peak fittings. Distance ratios in the distribution functions are in good agreement with those obtained by Scott. Intensity functions and distribution functions of argon were compared with the experimental work of others. Similar comparisons were made for xenon. For both liquids better agreement exists between the present work and theory; however, there is a much larger disparity between experiment and theory for xenon. Dissert. Abstr.

N68-25907 Louisiana State Univ., Baton Rouge.
LOW ENERGY EXCITATIONS IN LIQUID HELIUM
Peter Duane Skiff (Ph.D. Thesis) 1967 79 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-8798

A variational approximation method described by Valatin and Butler is used as a basis for describing the low temperature behavior of liquid Helium. It is assumed that the Fourier transform of the interaction potential of the Helium atoms has a Gaussian form, specified by two parameters. For a particular choice of these two parameters the ground state expectation value of the number of Helium atoms with zero momentum is calculated to be 8% in agreement with the experimental value deduced by Penrose and Onsager. For the same choice of parameters, a curve (called the dispersion curve) is calculated for the energy versus momentum relation for the elementary excitations in the liquid. However, this dispersion curve diverges increasingly from the experimental results of Henshaw and Woods as the momentum (and energy) of the excitations is increased from zero; and, in particular no minimum occurs. This result is interpreted as probably due to an inadequacy of the weak interaction assumption implied by the method of Valatin and Butler. Dissert. Abstr.

N68-25980 Minnesota Univ., Minneapolis.
OBSERVATION OF QUANTIZED CIRCULATION IN SUPERFLUID HELIUM
Stephen Carr Whitmore (Ph.D. Thesis) 1966 168 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-7801

Circulation of the superfluid component of liquid-helium II around a fine wire has been measured by means of the influence that the circulation exerts on the transverse vibrations of the wire.

The work is a repetition and extension of an experiment performed earlier by Vinen. It gives new evidence in support of the Onsager-Feynman hypothesis that circulation of superfluid helium is quantized in units of h/m, where h is Planck's constant and m is the mass of the helium atom. A fine wire is stretched down the center of a cylindrical vessel containing liquid helium, and the circulation is prepared by rotating the vessel around the axis of the wire while cooling from above T_λ Then the rotation of the vessel is stopped, and the wire is set into vibration by passing a current pulse through it in the presence of a transverse magnetic field. The free, slowly damped vibrations which follow can then be observed by means of the oscillatory e.m.f. induced along the wire. Dissert. Abstr.

N68-25989 Brown Univ., Providence, R. I.
A STUDY OF THE INTERACTION BETWEEN GRAVITATIONAL RADIATION AND MATTER
Fred Isaac Cooperstock (Ph.D. Thesis) 1966 58 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2227

This thesis is an attempt at improving the understanding of the interaction between gravitational radiation and matter. It is motivated by the fact that gravitational radiation plays an important role in Einstein's Theory of General Relativity but it has never been detected. With a straightforward application of the equation of geodesic deviation, it is demonstrated that the relative separation of two uncoupled test particles is unchanged in the field of a plane gravitational wave if the particles have no initial relative velocity. An electromagnetic model oscillator is introduced to study the interaction between a gravity wave and elastically coupled particles. The model consists of a high frequency electromagnetic wave which is bounced between two perfectly conducting capacitor plates. The plates are oppositely charged and the system is in equilibrium under the opposing forces of radiation pressure and the electrostatic attraction. Dissert Abstr.

N68-26002 Brown Univ., Providence, R. I.
ON THE ACOUSTIC WAVE EQUATION IN THE PRESENCE OF VIRTUAL MASS SOURCE AND FORCE DENSITIES
Herbert Kline (Ph.D. Thesis) 1966 191 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-2254

In this thesis several different, yet related, problems are considered. Calculations concerning themselves with standing waves of sound and those concerning themselves with traveling waves of sound share in common the idea of the acoustic wave equation in the presence of virtual mass source and force densities. Considered first is the problem, in one dimension, of forced oscillations and standing waves of sound in a cube-shaped resonator, the vibrating wall of the resonator being represented as a delta-function source which is then expanded in the normal modes of the resonator. Calculations are carried out first from the Eulerian point of view and then, secondly, from the Lagrangian point of view. The uncovering of a discrepancy in this connection, i.e., as between Eulerian and Lagrangian points of view, necessitates modification of the usual Lagrangian equation of continuity so that it be consistent with the Eulerian equation of continuity in the presence of sources, upon which modification the two viewpoints, Eulerian and Lagrangian, are found to be consistent. Dissert Abstr.

N68-26003 Brown Univ., Providence, R. I.
EFFECT OF DIFFUSION ON ULTRASONIC ATTENUATION IN MIXTURES OF HELIUM AND ARGON, AND HELIUM AND KRYPTON
Andre Kai-man Law (Ph.D. Thesis) 1966 163 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-2259

Measurements of the absorption of ultrasound of about 70 kHz in mixtures of helium and argon, and of helium and krypton, have been undertaken at several temperatures over a range from room temperature to 140°C and over a pressure range of about 15 to 160 mmHg. Measurements for He–A mixtures have been performed at 23, 70, 100, 120, and 140°C, and for He–Kr mixtures at 23, 50, 80, 100, 120, and 140°C. The composition of the mixtures ranges from a helium mole fraction (x_1) of 0.0 to 0.8 for the He–A mixtures and from x_1 = 0.15 to 0.85 for the He–Kr mixtures. Kohler's theory of absorption due to diffusion (mutual mass diffusion and thermal diffusion) in a mixture of two monatomic gases has been found to account successfully for the amount of absorption in excess of the contribution from viscosity and thermal conductivity which has been observed experimentally. Dissert. Abstr.

N68-26049 Washington State Univ., Pullman.
AN ANALYSIS OF THE MECHANISMS CONTROLLING THE POSITIVE ION EMISSION FROM HEATED Fe FILAMENTS
Georgious Antoniou Antypas (Ph.D. Thesis) 1967 66 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-9160

The behavior of the positive ion and electron current was studied as a high purity Fe filament passed through the $\alpha \rightleftarrows \gamma$ structural transformation. The simultaneity of the ion maxima and the $\alpha \rightleftarrows \gamma$ transformation is established. When an exhausted filament passing through the $\alpha \rightleftarrows \gamma$ transformation was bombarded by surface ionizable impurities, it was observed that the transformation produced a maximum in the positive ion current, while the $\gamma \rightarrow \alpha$ transformation produced a minimum. Studies of the electron current emitted as the filament passed through the $\alpha \rightleftarrows \gamma$ transformation indicated that the $\alpha \rightarrow \gamma$ transformation produces a minimum in the electron current, while the $\gamma \rightarrow \alpha$ transformation produces a maximum. Externally applied deformation to an almost exhausted filament did not produce any effects on the positive ion or electron currents, as the filament was passing through the $\alpha \rightleftarrows \gamma$ transformation. A detailed analysis of the stress distribution associated with the transformation would be able to quantitatively explain the experimental results. Dissert. Abstr.

N68-26070 Iowa State Univ. of Science and Technology, Ames.
USE OF CONTINUOUS MEASUREMENTS IN A DISCRETE KALMAN FILTER
Richard Ewers Horton (Ph.D. Thesis) 1967 60 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8914

Many physical measurement processes are contaminated with random noise by a variety of factors. Improved instrumentation can generally reduce the amount of contamination but cannot completely eliminate it. Linear filtering and prediction techniques have been applied to stochastic systems with continuous or discrete measurements. While continuous filters usually have no provision for utilizing discrete data, discrete filters can incorporate continuous measurements. One natural method of converting a continuous measurement to a discrete value is to sample the process. Under certain conditions, a better discrete value can be obtained by presmoothing the measurement process between discrete points in time. A discrete Kalman filter which averages the continuous measurement error between discrete points in time is analyzed, and results are compared through an example to those obtained with classical methods of filtering. Dissert. Abstr.

N68-26118 California Inst. of Tech., Pasadena.
THE ATTENUATION AND DISPERSION OF SOUND IN A CONDENSING MEDIUM. THE FLOW OF A GAS PARTICLE MIXTURE DOWNSTREAM OF A NORMAL SHOCK IN A NOZZLE
David Clark Wooten (Ph.D. Thesis) 1967 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8461

The attenuation of sound due to particles suspended in a gas was first calculated by Sewell and later by Epstein in their classical works on the propagation of sound in a two-phase

medium. In their work, and in more recent works which include calculations of sound dispersion, the calculations were made for systems in which there was no mass transfer between the two phases. In the present work, mass transfer between phases is included in the calculations. In the flow of a gas-particle mixture through a nozzle, a normal shock may exist in the diverging section of the nozzle. In Marble's calculation for a shock in a constant area duct, the shock was described as a usual gas-dynamic shock followed by a relaxation zone in which the gas and particles return to equilibrium. The thickness of this zone, which is the total shock thickness in the gas-particle mixture, is of the order of the relaxation distance for a particle in the gas. Dissert. Abstr.

N68-26123 Michigan Univ., Ann Arbor.
THE FORMATION OF DIFFRACTION IMAGES: FRESNEL IMAGES, THE COMPOUND EYE, AND HOLOGRAPHIC MICROSCOPY
John Talley Winthrop (Ph.D. Thesis) 1966 234 p
Available from Univ. Microfilms: HC $10.60/MF $3.05 Order No. 67-8369

In Part I the scalar diffraction integrals of Kirchhoff, Rayleigh and Sommerfeld are reviewed. An interpretation of the diffraction process is given in terms of the frequency-response function and spatial dispersion. For the special case of point source illumination and parabolic wavefronts the amplitude of diffraction may be expressed in terms of the convolution of the object transmittance and a Fresnel wave function. A description of the diffraction process is given in terms of orthogonal optical transformations. In Part II the convolution formulation of Fresnel diffraction is applied to the problem of Fresnel diffraction at an arbitrary plane periodic array (Fresnel images). The amplitude of diffraction at any plane is expressed as a linear superposition of equally displaced images of the original array (the superposition theorem). In Part III the possibility of the formation and functioning of diffraction images in the compound arthropod eye is considered. In Part IV the application of holography to the problem of X-ray and ultraviolet microscopy is considered. Dissert. Abstr.

N68-26253*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A 14 TESLA 15-CM BORE SUPERCONDUCTIVE MAGNET
W. D. Coles, E. R. Schrader (RCA, Harrison, N. J.), and P. A. Thompson (RCA, Harrison, N. J.) Washington 1967 17 p refs Prepared jointly with RCA, Harrison, N. J.
(NASA-TM-X-52330) CFSTI: HC $3.00/MF $0.65 CSCL 20C

Design and construction of the magnet and some initial test results are discussed. The magnet is a solenoid of 15 cm ID, 50 cm OD, and 35 cm length. Weight of the magnet is nearly 1000 lbs, and the stored energy when powered to maximum field strength approaches 2 megajoules. A composite Nb_3Sn, stainless steel, and silver superconductive ribbon of 90,000 m length and 0.23 cm width is used in the magnet. Field, strength, and stability requirements in different sections of the magnet led to the selection of 22 coil forms for winding 30 electrically distinct modules. Liquid helium is used for cooling. Tests were conducted to determine field values, current values, magnet and power characteristics, and liquid helium consumption. K.W.

N68-26282*# Illinois Univ., Urbana. Coordinated Science Lab.
A PROPOSED TEST OF THE EINSTEIN THEORY OF GRAVITATION BY MEANS OF AN UNSHIELDED ORBITING GYRO USING PASSIVE TELEMETRY
Duane H. Cooper, Gerald R. Karr, James L. Myers, and Dominic Skaperdas May 1968 417 p refs
(Grant NsG-443; Contract DAAB07-67-C-0199)
(NASA-CR-94933; R-378) CFSTI: HC $3.00/MF $0.65 CSCL 20J

Final report of a feasibility study of an experiment to measure the first-order precession, predicted by Einstein's General Theory of Relativity, of an earth orbiting, free gyroscope. The results of this study show that a relatively inexpensive experiment, using an unshielded gyro and a passive data readout and telemetry system, is now feasible for measuring this precession to an accuracy of about 1%. Author

N68-26370# Grunzweig and Hartmann A. G., Ludwigshafen am Rhein (West Germany).
INVESTIGATION OF A WIDE BAND NOISE GENERATOR Final Report, Mar. 1964–Feb. 1967
G. Kurtze and F. Mechel Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Mar. 1968 39 p refs
(Contracts AF 61(052)-779; AF 61(052)-931)
(AFFDL-TR-67-88; AD-668132)

Shock waves are generated by a displacement body rotating at the end of a rotor arm with supersonic velocity. The echoes of the shocks in a reverberant room build up a high-energy sound field with a broad and rather flat spectrum. Acoustic power up to 30 kW is generated with an efficiency of 23 percent. The measurement of the radiated acoustic power is described and the optimum shape and dimensions of the displacement body for good acoustic energy conversion are investigated. Design specifications for the rotor arm are given. Author (TAB)

N68-26404# ARO, Inc., Arnold Air Force Station, Tenn. Thermal Radiation Section.
ANGULAR DISTRIBUTION OF RADIATION REFLECTED FROM CARBON DIOXIDE CRYODEPOSITS FORMED ON 77 °K SURFACES Final Report, Jun. 1967–Jan. 1968
Arnold Eng. Develop. Center Apr. 1968 63 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-68-46; AD-668432)

The angular distribution of light reflected from carbon dioxide cryodeposits formed at various rates on polished copper and black substrates has been measured for various cryodeposit thicknesses and angles of incidence. Cryodeposits were found to reflect light essentially diffusely at thicknesses greater than about 100 microns. The specular reflection from both polished copper and black substrates could be reduced by as much as two orders of magnitude by a 100-micron-thick cryodeposit. Bragg interference, backscattering, scattering interference, and shifts of the angular location of the specular component were all observed and illustrated that light reflection from cryodeposits is a very complex phenomenon. Author (TAB)

N68-26435# Uppsala Univ. (Sweden). Inst. of Physics.
INFLUENCE OF ADSORBED GASES ON THE EMISSION OF X-RAYS FROM EXPLODING TUNGSTEN WIRES IN VACUUM
S. K. Handel and B. Stenerhag Oct. 1967 16 p refs Presented at the 4th Conf. on the Exploding Wire Phenomenon, Boston, 18–20 Oct. 1967
(UUIP-562; CONF-671044-2)

Undegassed and degassed tungsten wires, initially coated with a thin impurity layer consisting of tungsten oxide (WO_3) and graphite, have been exploded in vacuum, 2×10^{-6} torr. The 0.1 μF capacitor was discharged at an initial voltage of 20 kV. The loop inductance of the short-circuited system was 150 nH. Correlated measurements of x-ray emission from the "anode side" and dI/dt show that the emission of x-rays starts prior to the shunting discharge. The hard x-ray burst emitted is extremely short (half amplitude width of about 25 nsec) and reproducible both in time and intensity, provided the initial conditions are kept constant. Explosions of undegassed and degassed wires give maximum x-ray photon energies of 23 keV and 11.5 keV, respectively. The dI/dt signals obtained from both kinds of explosions are identifical, i.e., the gases initially adsorbed by the wire surface affect the emission of x-rays but not main discharge current. On the other hand, the main discharge current but not the hard x-ray emission is influenced by the impurity layer. Finally, the x-ray output versus the pressure of

the surrounding medium has been investigated. It is found that the x-ray burst is reproducible inside the pressure interval 10^{-6} torr to 1×10^{-2} torr. Author (NSA)

N68-26451# Gottingen Univ. (West Germany).
INTERACTION BETWEEN AIR FLOW AND AIRBORNE SOUND IN A DUCT. VOLUME 1: PROPAGATION OF SHOCK FRONTS AND NONLINEARITY OF PORUS ABSORBERS Final Report, Feb. 1964-Jan. 1965
P. A. Mertens Wright-Patterson AFB, Ohio AMRL Nov. 1967 34 p refs
(Contract AF 61(052)-666)
(AMRL-TR-67-120(1); AD-669085)

The sound propagation in moving air with locally varying flow velocity is investigated by means of shock waves from a spark discharge. To accomplish this, the wave fronts were photographed with a schlieren optics in a flow duct with a large flow boundary layer thickness. Results of these experiments agree with the theories of geometrical acoustics and can be incorporated into the design of ducts having air flow and airborne sound. Also investigated were properties of porous absorbers in the presence of an air flow. Results show a penetration of the absorber by the air flow yields a change of the flow resistance compared with still air. The acoustic flow resistance and the differential static flow resistance are experimentally found to have the same value. Moreover, it is proved that turbulent motions along the surface of the absorber do not affect the flow resistance appreciably. Author (TAB)

N68-26453# Oak Ridge National Lab., Tenn. Neutron Physics Div.
MAGNETIC FIELD COMPENSATION WITH PAIRS OF RECTANGULAR COILS
Ernest G. Silver 1 Mar. 1968 23 p ref
(Contract W-7405-ENG-26)
(ORNL-TM-2129) CFSTI: HC $3.00/MF $0.65

A group of FORTRAN programs is described dealing with the magnetic fields generated by rectangular pairs of current-carrying coils. A program is described for calculating the optimum separation distance between such a pair of coils for producing a field constant to second order at the center of symmetry of the coil pair. A program is described to calculate the currents required to compensate any arbitrary external field at the center of symmetry of any coil pair, and to obtain the resultant field at any point in space due to the external field and three mutually orthogonal pairs of compensating coils. Author (NSA)

N68-26542# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
THE PROBLEM OF RENORMALIZATION OF A SCALAR FIELD IN AXIOMATIC AND LAGRANGIAN FORMALISMS [PROBLEMA PERENORMIROVKI SKALYARNOGO POLYA V AKSIOMATICHESKOM I LAGRANZHEVOM FORMALIZMAKH]
M. K. Polivanov and A. D. Sukhanov 1967 23 p refs In RUSSIAN
(ITF-67-40)

The arbitrariness in the definition of various Green's functions is connected with account of the integral over a large circle in spectral representations. The relations between various Green's functions are found in renormalized and unrenormalized theories (with number renormalization). The corresponding results in axiomatic and Lagrangian formalisms are brought into agreement. It is shown how the arbitrariness of the Borchers type defining the Heisenberg field affects Green's functions. Author (NSA)

N68-26548 Brown Univ., Providence, R. I.
CONTROLLABLE STATES OF ELASTIC DIELECTRICS
Manohar Singh (Ph.D. Thesis) 1966 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-2289

Combinations of finite static deformations and static electric fields, which we call *controllable states*, of elastic dielectrics are described. The deformation and either the electric field or the dielectric displacement field are prescribed initially, and it is shown that the resulting state can be supported without mechanical body force or distributed charge in every homogeneous, isotropic, incompressible, elastic dielectric. It was asserted that every controllable state with either a prescribed electric field or a prescribed dielectric displacement field is among those described. Dissert. Abstr.

N68-26549# Goucher Coll., Towson, Md.
THE INFLUENCE OF SUBSTRATE TEMPERATURE ON THE STICKING COEFFICIENT OF ZINC ON GLASS
Barton L. Houseman and Barbara E. Marzocchi Edgewood Arsenal, Md. Nuclear Defense Lab. May 1968 27 p
(Contract DA-AMC-18-035-94(A))
(NDL-TR-106; AD-668252)

The influence of glass substrate temperature between room temperature and 95C on the sticking coefficient of zinc-on-glass in a vacuum of 0.000001 torr was studied. The sticking coefficient was found to be significantly higher at 65 to 95C. At room temperature no adsorption of zinc was observed even after the glass surface was exposed to a high flux of zinc vapor atoms for 15 minutes. Contamination effects on the sticking coefficient are described; it was noted that at temperatures within the range of 65 to 95C a uniform and continuous film of zinc deposited on glass slides cleaned with nitric acid and water. The effect of change in the flux of the zinc vapor on the sticking coefficient is also discussed. Three theories are proposed to explain the phenomena of increased sticking of zinc with increased substrate temperature. Author (TAB)

N68-26584# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CATALOGUE OF PARAMETERS OF POLARIZED LIGHT REFLECTED BY TERRESTRIAL ROCKS [KATALOG PARAMETROV POLYARIZOVANNOGO SVETA, TRAZHENNOGO ZEMNYMI GORNYMI PORODAMI]
Ye. K. Kokhan 29 Jun. 1967 25 p refs Transl. into ENGLISH from Izv. Glavnol Astron. Observ. (Pulkovo), v. 23, no. 5, 1964 p 93-106
(FTD-HT-67-172; AD-668051)

The author summarizes the history of studies on reflected polarized light from solid bodies. His objective in the present investigation is measurement in natural rock material of changes in degree of polarization of reflected light (of various wavelengths) depending on the phase angle. Curves were obtained for angular changes in the polarization plane and the results were compared with curves for the lunar surface. An effort was made to obtain specimens corresponding as nearly as possible to lunar types. Twelve specimens were studied (obsidian, vesicular andesite, basalt, gneissic granite, biotite granite, quartz, prismatic quartz, ocherous limonite, two varieties of tuff, and scoria) in the uncrushed state and in crushed form. Grain size of the rocks was selected on conclusions concerning probable microrelief on the moon. The studies were made in the Planetary Laboratory of Leningrad State University, using the polarimeter of the Pulkovo Observatory. This polarimeter was attached to the indicating device (indicatometer) of the University. The model for the experiment was set up with a lamp to represent the sun, the specimen to represent the moon, and the polarimeter to represent the earth. All specimens were investigated with yellow and green Schott filters and without any filter. Measurements were made at various incident angles at two angles of reflection (0 and 45 degrees). The results are tabulated. Author (TAB)

N68-26596# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORETICAL CALCULATION OF CERTAIN QUANTITIES, INFLUENCING THE TRANSMISSION OF SPATIAL CHARACTERISTICS OF THE APPARENT SOURCE OF SOUND [TEORETICHESKIY RASCHET NEKOTORYKH VELICHIN, VLIYAYUSHCHIKH NA PEREDACHU PROSTRANSTVENNYKH KHARAKTERISTIK KAZHUSHCHEGOSYA ISTOCHNIKA ZVUKA]

V. S. Man'kovskiy 25 Jul. 1967 24 p refs Transl. into ENGLISH from Tr. Leningr. Inst. Kinoinzhenerov (Leningrad), no. 10, 1964 p 75–88

(FTD-MT-67-73; AD-668061)

The method considered permits determining, as the direct and reflected energy are changed, the acoustic ratio and time shifts between signals for each microphone and the whole stereophonic system, depending upon the position of the sources and receivers relative to one another and relative to the reflecting surfaces of the primary location and also depending upon the acoustic properties of the room. These dependences determine the perception of the spatial sound pattern during stereophonic transmissions.

Author (TAB)

N68-26609# Auburn Univ., Ala. Auburn Research Foundation.

A NOTE ON THE ANALYTIC PLATFORM

S. N. James, D. W. Kelly, and J. L. Lowry 18 Feb. 1967 8 p refs

(Contract NAS8-20004)

(NASA-CR-61405) CFSTI: HC $3.00/MF $0.65 CSCL 20J

A uniqueness solution to the transformation differential equations is presented for the case when the exact angular velocity of the vehicle is known. A set of first order differential equations is derived which satisfies the Lipschitz conditions. The law of the mean is applied to the real valued functions in the equations. Also presented are the differential equations relating the transformation matrix (from a vehicle coordinate system to a space-fixed coordinate system) to the angular velocities of one of the coordinate systems (vehicle coordinate system). It is proven that the solutions are unique for a given set of initial conditions. A.L.

N68-26618# Ballistic Research Labs., Aberdeen Proving Ground, Md.

SINGLE-WIRE TORSIONAL PENDULUMS AND THEIR USE IN THE MEASUREMENT OF MOMENTS OF INERTIA

Robert W. Deas and Wallace M. Werner Dec. 1967 40 p refs

(BRL-MR-1891; AD-667963)

The theory of single-wire torsional pendulums, including second order effects, is discussed. The theory is applied to the use of torsional pendulums in measuring moments of inertia. Two types of torsional pendulums designed for moment of inertia measurements are described: one for odd-shaped bodies and one for artillery projectiles. A data reduction program for digital computers is included.

Author (TAB)

N68-26631# Ohio State Univ., Columbus. ElectroScience Lab.

INTERPRETATION AND APPLICATION OF TRANSIENT AND IMPULSE RESPONSE APPROXIMATIONS IN ELECTROMAGNETIC SCATTERING PROBLEMS

David L. Moffatt 27 Mar. 1968 228 p refs

(Contract F19628-67-C-0239)

(OSURF-2415-1; AFCRL-67-0690; SR-1; AD-668124)

A linear system analysis is applied to electromagnetic scattering problems. The relationship between the incident and scattered fields is reduced to a one-dimensional linear system by suitable restrictions, and modeled as a linear two-port with time-invariant parameters. The two-port characterized by a real, time-dependent impulse response function and a transform-related complex, frequency-dependent phasor response. Two fundamental approaches for obtaining approximate solutions to electromagnetic scattering problems are seen. Estimates of either the frequency-dependent phasor response or the time-dependent impulse response can be attempted. The material in this study is concerned with the latter approach. Author (TAB)

N68-26749# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

ON SUMMATION OF CONTRIBUTIONS FROM THE FEYNMAN DIAGRAMS: AN EXISTENCE THEOREM. 3

D. Ya. Petrina 1967 28 p refs

(ITF-67-48)

Linear equations are developed for the Euclidean Green's functions outside perturbation theory. The operator A is proved to be self-adjoint. It is shown that the iterations of the Green's function equations yield all the connected Feynman diagrams.

Author (NSA)

N68-26774# International Union of Pure and Applied Chemistry, Basle (Switzerland).

BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. VOLUME 1967, NUMBER 4, OCTOBER, NOVEMBER, DECEMBER 1967

J. J. Diamond (Natl. Bur. of Std., Washington, D. C.) [1968] 84 p refs

(NP-17284) Available from J. J. Diamond, Natl. Bur. of Std., Washington, D. C.: Free

A bibliography containing 866 references is presented on: devices for achieving, measuring, and controlling temperatures above 1500°C; properties, at temperatures below 1000°C, of materials which melt above 1500°C; properties, at temperatures above 1000°C, of materials which melt above 1500°C; properties, at temperatures above 1000°C, of materials which melt below 1500°C; phase equilibria; and reactions at temperatures above 1000°C.

NSA

N68-26917 Minnesota Univ., Minneapolis.

CONTRIBUTIONS TO THE THEORY OF WAVE PROPAGATION IN PERIODIC STRUCTURES

Jack Richard Williams (Ph.D. Thesis) 1966 202 p

Available from Univ. Microfilms: HC $9.25/MF $3.00 Order No. 67-7803

It is the purpose of this work to bring together and reconcile various theoretical descriptions of steady-state wave propagation in a class of periodic structures, to re-examine and modify these descriptions in an effort to clear up certain ambiguities and misconceptions, to develop the theory further by investigating its consequences and introducing new material, and to extend its applicability by removing or relaxing some of the conditions and restrictions assumed in previous studies. Wave propagation in a periodic structure represented as a cascade of identical two-ports can be studied by a circuit approach, which yields wave solutions at the reference planes and by inference important characteristics of the propagation. Floquet's theorem, also commonly applied in the analysis of periodic structures, applies strictly to propagation in continuous periodic media. The circuit model, developed for reciprocal two-ports, is extended to include the nonreciprocal two-port; and Floquet's theorem, which is similarly restricted, is suitably modified. The theory is then applied to a class of nonreciprocal, active structures, for which a procedure is developed that permits a coupled-mode approach to the interaction between a space-charge wave and a space-harmonic system. The coupled structure, for which the two-ports in the cascade representation are no longer identical, is nevertheless brought within the scope of the theory. Dissert. Abstr.

N68-26920 Stanford Univ., Calif.

PARAMETRIC INTERACTION OF LIGHT WITH ACOUSTIC WAVES

Donald Elmer Caddes (Ph.D. Thesis) 1967 187 p

Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-7859

This study presents the results of a theoretical and experimental investigation of parametric interactions of light and sound. The central objective of this work was the demonstration of electrostrictive mixing in solids. In these experiments, two light waves of slightly different frequencies interact within the volume of a crystal to produce an acoustic wave at the difference frequency. In the theoretical treatment, the formalism common to all traveling-wave parametric interactions is applied to the coupling of two optical plane waves and an acoustic plane wave. The first successful generation of acoustic waves in solids through the electrostrictive mixing of two light waves is described. In the initial experiments, 700 MHz sound was generated in single crystals of strontium titanate, rutile, quartz, and sapphire. Evaluation is made of the possibility of using Brillouin scattering to probe sound waves generated by CW electrostrictive mixing. Dissert. Abstr.

N68-26928*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE ADSORPTION OF ARGON AND NITROGEN ON STAINLESS STEEL AT 195 °K and 303 °K IN THE PRESSURE RANGE 10^{-8} TO 10^{-7} TORR

James P. Wightman (Va. Polytech. Inst.) and John P. Mugler, Jr. 1967 33 p refs Presented at the 45th Ann. Meeting of the Va. Acad. of Sci., Space Sci. and Technol. Sect., Norfolk, Va., 5 May 1967

(NASA-TM-X-60208) CFSTI: HC$3.00/MF$0.65 CSCL 20

Experimental details are presented on measurements made of the adsorption of argon and nitrogen at low pressures on stainless steel. The extent of adsorption was inferred from the calculated expansion ratios, which were defined as the pressure in the storage vessel before expansion to the pressure in the adsorption vessel after expansion. Tabulations give the expansion ratios for argon, and for nitrogen at 303° and 195°K. Based on these data, it was concluded that adsorption of nitrogen does not occur to a significant extent on stainless steel when the temperature is decreased from 303° to 195°K in the pressure range 10^{-8} to 10^{-7} torr. M.G.J.

N68-26929# Laboratoire de Physique Theorique et des Hautes Energies, Nice (France).

CONSPIRACY RELATIONS FORMULATED IN TERMS OF DIRECT CHANNEL AMPLITUDES

Michel Le Bellac Feb. 1968 7 p refs

(NTH-68/1) CFSTI: HC$3.00/MF$0.65

Consideration is given to a previously proposed formula for expressing the contribution of a Regge pole to direct S-channel helicity amplitudes (SHA) for any given reaction. The procedure avoids the complicated task of extracting all kinematical singularities and constraints from T-channel helicity amplitudes (THA); however, the general solution applies only if the Regge pole chooses evasion. The results are generalized to the case where one exchanges a Lorentz pole characterized by a quantum number, with attention centered on the asymptotic behavior of the SHA. Author

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N68-25665# Laboratoire de Physique Theorique et des Hautes Energies, Nice (France) Faculte des Sciences.

GENERALIZED UNCERTAINTY RELATIONS FOR MANY-FERMION SYSTEMS

Jean-Marc Levy-Leblond [1967] 4 p refs

(NTH-68/3) CFSTI: HC$3.00/MF$0.65

Diagonalizing the Hamiltonian for N identical fermions interacting via two-body harmonic forces, generalized uncertainty relations are obtained. This gives a rigorous foundation to the usual heuristic interpretation of the Pauli principle. Author

N68-25675# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).

ON THE PERIPHERALITY OF MULTIPLE PRODUCTION PROCESSES

A. Krzywicki Apr. 1968 5 p refs

(TH-68/13) CFSTI: HC$3.00/MF$0.65

Strong dependence on moments of secondaries of the phases of amplitudes for production processes has been recently uncovered. It may be interpreted as reflecting the fact that secondaries are created on peripheral trajectories. It has recently been shown that the phase of an amplitude for multiple production of mesons has to depend strongly on moments of secondaries. Only then can elastic scattering be peaked forward as sharply as it is observed experimentally. This result has been obtained using particular models of multiple production, for example the uncorrelated jet model. Author

N68-25681# Los Alamos Scientific Lab., N. Mex.

X-RAY SCATTERING FACTORS COMPUTED FROM NUMERICAL HARTREE-FOCK WAVE FUNCTIONS

Don T. Cromer and Joseph B. Mann 11 Mar. 1968 69 p refs

(Contract W-7405-ENG-36)

(LA-3816) CFSTI: HC$3.00/MF$0.65

X-ray-scattering factors for neutral atoms from He to Lw and for most of the chemically significant ions through Lu^{3+} have been computed from numerical Hartree–Fock wave functions. The results are given in numerical tables and in the form of coefficients for an analytic function. Author (NSA)

N68-25692# California Univ., Livermore. Lawrence Radiation Lab.

THE CALCULATION OF LOW-ENERGY (N, P) REACTIONS

H. F. Lutz and J. D. Anderson* 6 Dec. 1967 13 p refs

(Contract W-7405-ENG-48)

(UCRL-50359) CFSTI: HC$3.00/MF$0.65

The statistical theory of nuclear reactions is used to calculate low-energy (n,p) reactions on unstable isotopes near mass numbers 45 and 90. Neutron energies up to 1 MeV are considered. Isomeric states of unstable nuclei are also taken as target nuclei; the results indicate that the (n,p) cross sections on these levels can be quite large. The transmission coefficients are calculated from an optical model, and Moldauer's code NEARREX is used to make the statistical model calculation. Author (NSA)

N68-25694 European Organization for Nuclear Research, Geneva (Switzerland). Proton Synchrotron Machine Div.

A SOVIET FORMALISM IN BETATRON OSCILLATION THEORY AND ITS COMPARISON WITH OTHER CONCEPTS

J. Fronteau and R. Gouiran 22 Apr. 1968 25 p refs

(CERN-68-12)

The theory of betatron oscillations in a synchrotron is presented according to a logical development using first the classical COURANT–SNYDER formalism and second a Soviet formalism. It is then possible to compare the concepts and the terminology used in both cases, and this could help people who will have to work on the Serpukhov synchrotron. The Soviet formalism is based on the concept of complex "Floquet function $\phi(s)$" and of its derivative $\phi'(s)$, as a solution of the equation of motion. The phase $\psi(s)$ of the Floquet function and the phase $\chi(s)$ of its derivative are used for the representation of motion and for the computation of the transfer matrices. A table gives the correspondence between the

usual β, γ, α, μ, ψ parameters and the soviet terms $|\phi|$ $|\phi|$, $|\phi|'$, ψ, χ and μ. A similar correspondence is done for the computation of the perturbed closed orbit. Author

N68-25749# Helsinki Univ. (Finland). Research Inst. for Theoretical Physics.
PROCEEDINGS OF THE LIPERI SUMMER SCHOOL IN THEORETICAL PHYSICS, 1966. B. NUCLEAR PHYSICS
1967 165 p
(NP-17228)

In the conference papers presented, attention was focused on various aspects of nuclear physics research. Summary information is presented on (1) collective effects in spherical nuclei, (2) parity deformation and pairing within a solvable model, (3) pairing-model with special attention to deformed model, and (4) optical potentials for composite particles. Some problems in the theory of direct reactions are discussed, and their solution, if known, is indicated. The alpha-nucleus potential is studied, and a model of two spinless particles in a harmonic oscillator potential is described. B.S.D.

N68-25813# Societe d'Etudes et de Developpement des Applications Derivees Electronique et Mecanique, Paris (France).
THEORETICAL AND EXPERIMENTAL STUDY OF THERMAL NEUTRON FLUXES IN HYDROCARBONS AND APPLICATION OF THE RESULTS TO THE MEASUREMENT OF THEIR DENSITY AND COMPOSITION [ETUDE THEORIQUE ET EXPERIMENTALE DES FLUX DE NEUTRONS THERMIQUES DANS DES HYDROCARBURES ET APPLICATION DES RESULTATS A LA MESURE DE LEUR DENSITE ET A LA RECHERCHE DE LEUR COMPOSITION]
P. Corompt, J. Molinari, and P. Calmels Brussels Apr. 1968 101 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-089-64-12 IRAF)
(EUR-3624.F) CFSTI: HC $3.00/MF $0.65

Plant control of the physico-chemical properties of a hydrocarbon necessitates samplings and laboratory analyses which are incompatible with automation and optimization of production. In this study the possibility is examined of using penetrating nuclear radiations for the continuous in-channel measurement of the density and chemical composition of hydrocarbons. The solution adopted is the linking of a gamma-radiation absorption measurement with a measurement of the thermalization of neutrons emitted by a sealed americium-241/beryllium source. The construction of an apparatus was preceded by an experimental and theoretical study on neutron scattering in hydrocarbons. The results from this study relate to the thermal-flux distribution in the vicinity of a neutron source. They can be generalized and extended to cover a number of hydrogeneated media. The precision of the density and chemical composition (C/H ratio) measurements obtained with such a combination of gamma-radiation and neutrons is limited by the statistical fluctuations of counting and above all by the non-linearity of the phenomena. In the most favorable case, with the aid of calibration nomograms for the neutron probe, the precision did not exceed 0.2%. Author

N68-25856# Tokyo Univ. of Education (Japan). Dept. of Physics.
STUDY OF THE EXCITED STATES OF ^{4}He THROUGH THE ^{4}He(GAMMA,P)^{3}H REACTION
J. Sanada, M. Yamanouchi, N. Sakai, and S. Seki Apr. 1968 32 p refs
(TUENS-2) CFSTI: HC $3.00/MF $0.65

Proton spectra from the ^{4}He(γ,p)^{3}H reaction were measured by use of 32 MeV bremsstrahlung X-rays and nuclear plates at 45°, 90° and 135° angles. The sharp resonance peaks reported by Milone were not found. Instead, two broad peaks at 24 and 27 MeV were found. The angular distribution of the two peaks was almost proportional to $\sin^2\theta$, suggesting that the reaction proceeds mainly through E^1 absorption. An analysis to fit the data by the use of two non-interfering resonances showed that the lower 1^-, $T=1$ state at 25 MeV in ^{4}He is mainly of $^1P_1$ configuration. Author

N68-25860# Technische Hochschule Munchen (West Germany).
SMALL ANGLE SCATTERING OF SUBTHERMAL NEUTRONS ON PLASTICALLY DEFORMED CUBE-FACE CENTERED METAL-SINGLE CRYSTALS [KLEINWINKELSTREUUNG SUBTHERMISCHER NEUTRONEN AN PLASTISCH VERFORMTEN KUBISCH-FLAECHENZENTRIERTEN METALL-EINKRISTALLEN]
Peter Herget (Ph.D. Thesis) 26 Jul. 1967 115 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Previous measurements of small-angle scattering of subthermal neutrons on cold-worked polycrystalline copper were extended to plastically deformed copper single crystals. Doping was used to grow single crystal rods with an orientation permitting a high dislocation density in a cleavage system during plastic deformation at 78°K. Disc-shaped samples were prepared from the deformed rods and examined for small-angle scattering. Two total-reflection radiation tubes with 7 and 13 Å mean wave lengths served as neutron sources. Scattering patterns were measured by means of photographic plates. The measured azimuthal anisotropy of the scattering intensity during injection into the cleavage system agreed with theoretical results. A square relationship between dislocation density and shear stress during deformation, theoretically determined by other investigators, was not observed. Also measured was the small-angle scattering of a plastically deformed nickel single crystal in magnetic fields of various strength, and agreement between measured and calculated azimuthal anisotropy was again observed. Transl. by K.W.

N68-25876 Arkansas Univ., Fayetteville.
EXCITATION TRANSFER IN HELIUM
Richard Blair Kay (Ph.D. Thesis) 1967 141 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-8729

The apparent lifetimes of the n ^{1}P, 3 ^{1}D, 4 ^{1}D and 3 ^{3}D levels of helium are studied as a function of pressure. The collisional transfer of excitation from n ^{1}P levels to nF levels is conclusively shown to be an important mechanism in populating D levels. It is found that the Wigner spin rule inhibits collisional transfer between 4 ^{1}P and 4 ^{3}F levels. For $n>4$ the n ^{1}P transfer to n ^{3}F levels is about three times greater than to the n ^{1}F levels. For $n>4$, the cross sections for collisional transfer from nF to n ^{1}P levels are found to be about 10 per cent of those for the reverse process. This result is in agreement with the principle of detailed balance. The collisional n ^{1}P–nF transfer cross sections are measured and appear to increase approximately as n^4. The pressure dependence of the apparent 3D cross sections are calculated using the above measurements in conjunction with the n ^{1}P–nF transfer model. The results are found to be in excellent agreement with experimental measurements. Dissert. Abstr.

N68-25885# Atomic Energy of Canada, Ltd., Chalk River, (Ontario). Metal Physics Branch.
THE EFFECT OF THE FAST NEUTRON SPECTRUM ON THE RATE AND DISTRIBUTION OF DAMAGE IN ZIRCONIUM
G. R. Piercy Apr. 1968 32 p refs
(AECL-3086) Available from Atomic Energy of Can., Ltd., Chalk River: $1.00

The damage rate produced by neutron irradiation of zirconium is calculated in terms of the energy given to the lattice. The effects of anisotropic elastic neutron scattering, inelastic neutron scattering, and energy loss to electron excitation using Lindhard's theory, are included. The results are applied to correlate the damage rate in seven different reactor spectra in terms of the associated ^{58}Ni monitor activity. The number of damage regions as a function of their lattice energy is also estimated and applied to several experiments. Author

N68-25896 Tokyo Univ. of Education (Japan). Dept. of Physics.
SU(3) CROSSING RELATION FOR MESON-BARYON SCATTERING AND REGGE POLE THEORY

Syurei Iwao and Sunao Sakai Apr. 1968 12 p refs
(TUEP-68-6) CFSTI: $3.00

The meson-nucleon scattering data from 6-18 GeV/c have been analysed under the hypotheses of the SU(3) crossing relation and the regge pole theory. The cross sections associated with the unitary singlet trajectory are explained well with the parameters of the Pomeranchuk trajectory in the current analysis. Those associated with the 8_S trajectory show some structure and require to introduce new octet tensor mesons in addition to known ones. The factorization does not seem to work for the 8_A associated cross sections and hence the same for the ρ and ω trajectory respectively. The $10+10^*$ and 27 plot associated cross sections are consistent with zero within the experimental error. The possible physical interpretation of this result is discussed. Author

N68-25911 Michigan Univ., Ann Arbor.
AN EXPERIMENTAL DETERMINATION OF THE SPIN EXCHANGE CROSS SECTION OF K 39 AND CS 133
Thomas Edison Stark (Ph.D. Thesis) 1966 73 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-8379

An important parameter in many optical pumping experiments is the cross section for spin-exchange collisions. This thesis reports a value for the exchange cross section for collisions between potassium atoms (K^{39}). The measurements employ the standard techniques of electron paramagnetic resonance (EPR). A microwave absorption spectrum is obtained. The spin-exchange collision rate is found by measuring the line widths of isolated transitions and the alkali density determined from an absolute calibration of the microwave spectrometer. The role of spin exchange collisions as a broadening mechanism for magnetic dipole transitions is examined by means of the density matrix formalism. The spin-exchange cross sections for collisions between K^{39} atoms is 1.45×10^{-14} cm^2, with an assigned probable error of $\pm$ 20%. Also reported in this thesis is a value for the exchange cross section for cesium (Cs^{133}). In the case of cesium the hyperfine coupling is sufficiently strong that the Paschen-Back region is not reached for magnetic fields corresponding to the use of X-band microwaves. The measured value of the exchange cross section for Cs^{133} is $1.8_1 \times 10^{-14}$ cm^2, with an assigned probable error of $\pm$ 20%. Dissert. Abstr.

N68-25924 Rochester Univ., N. Y.
STUDIES ON SOME CONSEQUENCES OF ALGEBRA OF CURRENTS AND MODELS OF ELEMENTARY PARTICLES
Mohinder Paul Khanna (Ph.D. Thesis) 1967 104 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8960

The algebra of currents has been used to deduce some of the consequences of the conventional symmetry groups. It is shown first that for the SU(6) and the SU(4) algebras generated by currents, a consistent solution for the matrix elements of the currents is obtained only for the states at rest. It is then shown that if, instead, the algebra of the group $SU(6)_w$ is employed, one is able to get the SU(6) symmetry results for the axial vector coupling constant and the d/f ratio, working with states with arbitrary but collinear momenta. The equal time commutators of the components of the electromagnetic current are considered, with a view to test the validity of various field-theoretic models of elementary particles. The SU(3) symmetry, which is known to be valid to a good approximation for the strong interactions, find interactions, finds a simple explanation in terms of a number of models of elementary particles. Dissert. Abstr.

N68-25933 Michigan Univ., Ann Arbor.
DEUTERON PRODUCTION IN PROTON-PROTON COLLISIONS FROM 1.5 TO 3 GEV
David Earl Pellett (Ph.D. Thesis) 1966 165 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-8325

The differential cross section for deuteron production in proton-proton collisions was measured for incident proton kinetic energies of 1.55, 2.5, and 2.9 GeV. Measurements were made at laboratory angles of 5.9°, 11.55°, 15.72°, and, at the two higher energies, at 20° relative to the beam direction for deuteron laboratory momenta in the range 1.0–2.4 GeV/c. The experiment was performed in an external proton beam of the cosmotron at Brookhaven National Laboratory. A system of scintillation and Cerenkov counters was used to identity deuterons by momentum analysis and time-of-flight techniques. The differential cross sections are presented in the laboratory and center of mass (c.m.) systems. Plots are given of the cross section versus the invariant mass of the system of particles formed with the deuteron in the collisions. Total cross sections were obtained by integrating a smooth function fitted to the c.m. data at each energy. Dissert. Abstr.

N68-25947 California Univ., Berkeley.
MEASUREMENT OF POLARIZATION IN NEGATIVE PION-PROTON SCATTERING FROM 229 TO 390 MILLION ELECTRON VOLTS
John Frederic Arens (Ph.D. Thesis) 1966 49 p Sponsored by AEC
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8513

The π^-p polarization parameter was measured at several energies and angles using a polarized proton target at the 184" cyclotron. The data at 229 MeV covered the angles between 150° and 180° in the center-of-mass system; at 318, 337, and 390 MeV the angles between 70° and 180° were included. Scintillation counter hodoscopes were used in coincidence to detect both the pions and recoil protons. A small computer was used on line to facilitate data handling and storage on magnetic tape. Phase shift analyses using this and other published data were made at the two lowest energies. Dissert. Abstr.

N68-25948 Rochester Univ., N. Y.
MUON-PROTON ELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS
Hans von Briesen, Jr. (Ph.D. Thesis) 1967 161 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-8980

A measurement of the differential cross section for muon-proton elastic scattering has been performed for 4-momentum transfers between 0.62 BeV/c and 1.1 BeV/c (10 to 31 f^{-2}). The aim of the experiment was to test for any difference between the electromagnetic interactions of the muon and the electron by direct comparison with measurements of electron-proton elastic scattering. Incident muons of momenta between 1.0 and 6.0 BeV/c were obtained with a flux of $\approx 10^6$ per 10^{11} internal protons and a pion contamination of $\approx 10^{-6}$. The beam was passed through a liquid hydrogen target 6 feet long and 18 inches in diameter, around which was placed an array of spark chambers and scintillation counters. For each detected scattering event, the trajectories of the scattered muon and the recoil proton were measured, and the kinetic energy of the recoil proton was taken from its range, measured in a heavy-plate spark chamber. Dissert. Abstr.

N68-25954 Rochester Univ., N. Y.
$\pi^+ - p$ INTERACTIONS AT 900 MeV
Wesley James Metzger (Ph.D. Thesis) 1967 138 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-8965

The Brookhaven National Laboratory 20-inch liquid hydrogen bubble chamber was exposed to a separated beam of π^+ mesons, having a laboratory momentum of 1.02 Bev/c, at the Alternating Gradient Synchrotron. In 18,500 frames, about 6000 events were found and measured. The differential cross section of cross section for elastic scattering was measured. The forward part was compared to (a) the optical model and (b) an exponential in the square of

the four-momentum transfer. A Monte Carlo program is used to generate the mass spectra for each intermediate state. A linear combination of these is fit to the experimental mass spectra. The mass spectra were fitted with a sum of the π+N*+(1236) intermediate state and nonresonant three body phase space. Dissert. Abstr.

N68-25960# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).

A REVIEW OF HIGH ENERGY WORK IN QUANTUM ELECTRODYNAMICS

V. Silvestrini 28 Mar. 1968 28 p refs Presented at the 3d Moriond Meeting on Electromagnetic Interactions, Lac de Tigres, 9–19 Mar. 1968 *Its* Nota Interna No. 394
(LNF-68/17) CFSTI: HC $3.00/MF $0.65

Test data on the validity of quantum electrodynamics (QED) at high energy are reviewed as a basis for understanding in which directions and to what extent a breakdown of QED might be expected. A breakdown of QED is defined as any modification of the Lagrangian density, and it is pointed out that models of modified QED theories are usually built in terms of modifications of vertexes and/or propagators. Several examples are included to show propagator and vertex modifications. Checks on the validity of QED for electrons and muons are discussed in relation to experiments concerning the static properties, high energy experiments, and tests of particular models. A reference bibliography is included. M.G.J.

N68-25979 Minnesota Univ., Minneapolis.

A STUDY OF THE BARYON RESONANCES

David Michael Brudnoy (Ph.D. Thesis) 1966 124 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7705

It is shown that in processes in which high spin resonances appear, the usual method of calculating with an explicit propagator function becomes most cumbersome due to the length of the propagator function for higher spin. Constructing the Parita-Schwinger wave functions explicitly and using them in the definition of the propagator, removes much of the difficulty in properly handling the various spin and kinematic factors in calculating resonance transition amplitudes and decay widths. In particular the cases of elastic meson-nucleon and photo-pion production resonance reactions are extremely simple to calculate due to the small number of terms needed to describe these reactions. The phenomenological coupling constant coupling resonance to meson and nucleon can be calculated from the experimental width of the resonance. Dissert. Abstr.

N68-25985*# Pittsburgh Univ., Pa. Space Research Coodination Center.

TRANSFER OF EXCITATION ENERGY FROM NITROGEN MOLECULES TO SODIUM ATOMS

J. E. Mentall, H. F. Krause, and W. L. Fite 29 May 1967 16 p refs Presented at the Faraday Soc. Gen. Discussion on Mol. Dyn. of the Chem. Reactions in Gases, Toronto, Sep. 1967
(Grant NsG-416)
(NASA-CR-87587; SRCC-46) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Experiments were performed in which a beam of N_2, issuing from a furnace source operating at temperatures from 2000° to 3000°K, crossed a beam of sodium atoms. Sodium D-line radiation was observed as a product of the collisions of the two beams. The radiation appears to occur primarily from the transfer of internal energy in the diatomic molecule, which because of the nature of the molecules must be vibrational and rotational only, into electronic energy in the sodium, presumably through the formation of a transitory NaN_2 complex. On the assumption that only internal energy transfer is involved, rate coefficients of approximately 10^{-10} cm^3/sec are found for those molecules with sufficient internal energy to excite the sodium. Weak temperature dependences of the observed rate coefficients are discussed. Author

N68-25991 Western Reserve Univ., Cleveland, Ohio.

QUASIPARTICLE RANDOM-PHASE APPROXIMATION IN ODD-ODD NUCLEI AND THE NEUTRON-PROTON INTERACTION

Donald Milton Rote (Ph.D. Thesis) 1967 160 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-8849

One of the motives for studying nuclear structure has been the determination of the nature of the effective residual two-body force in nuclei. For heavy even-even and odd-mass nuclei, calculations using modern many-body methods have been fairly successful in reproducing systematic low energy spectroscopic data by representing the residual interaction as a sum of two components: The pairing force (producing short-range correlations) and the quadrupole force (causing long-range correlations). On the other hand, the status of the residual neutron-proton (n-p) interaction in odd-odd nuclei remains somewhat chaotic. Systematic studies have been directed mostly toward establishing empirical coupling rules. The moderate success of these rules has been the subject of much analysis, but little has actually been learned about the effective residual n-p interaction from the systematic point of view. Dissert. Abstr.

N68-26008 California Univ., Berkeley.

PART 1: INTENSITY CORRELATIONS IN INELASTIC SCATTERING EXPERIMENTS. PART 2: QUANTUM BEAT AND LEVEL CROSSING EXPERIMENTS UTILIZING ELECTRONIC EXCITATION

Robert Lincoln Kelly (Ph.D. Thesis) 1966 84 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8587

Measurements of space-time correlations in the intensity of a beam of scattered particles yield information about the scatterer. Goldberger and Watson have developed a theory of such measurements appropriate to the case of nearly elastic scattering; in this paper we extend their theory to the case of inelastic scattering. The main result of our work is that under certain experimental conditions the correlated counting rate in an inelastic scattering experiment is of a form equivalent to the correlated counting rate for an incoherent beam of particles emitted by a source. This result applied, in particular, to Raman or Brillouin scattering of light by phonons in an extended target. However, estimates of the signal to noise ratio for this case indicate that it may not be possible to observe intensity correlations in Raman or Brillouin lines using presently available light sources. The coherent excitation of several atomic status by inelastic electron scattering and their subsequent radiative decay is considered. General expressions for the photon counting rate in a quantum beat experiment, and the total number of photons counted in a level crossing experiment are derived. Dissert. Abstr.

N68-26018 California Univ., Berkeley.

CROSS SECTIONS FOR ELECTRON CAPTURE BY FAST PROTONS IN HYDROGEN, HELIUM, NITROGEN AND ARGON

Leland Merritt Welsh (Ph.D. Thesis) 1966 80 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8669

Measurements have been made of cross sections for electron capture by protons, from 440 keV to 13.75 MeV in N_2 and in Ar; to 5.41 MeV in He; and to 2.45 MeV in H_2. These results are presented, along with electron-loss cross sections for the same gases at 1.027 and 2.44 MeV. The measurements were carried out through analysis of particle beam composition after exit from a gas target of known composition and thickness. The beam was separated magnetically, and the charged and neutral components were detected by Faraday cup and scintillator, respectively. Our results overlap, between 440 keV and 1 MeV, the experimental results of Barnett and Reynolds. The σ_{10} cross sections in this

region have the same general behavior, but are larger by an amount varying from roughly 10% in hydrogen to 50% in argon.
Dissert. Abstr.

N68-26048 Cornell Univ., Ithaca, N. Y.
PHOTOPRODUCTION OF WIDE ANGLE ELECTRON PAIRS FROM CARBON
Charles Kent Sinclair (Ph.D. Thesis) 1967 121 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-9200

The cross section for the photoproduction of high energy electron positron pairs from Carbon at large angles to the incident photon has been measured using a magnet and spark chamber system in conjunction with a 2.2 BeV electron synchrotron. Both members of the pair were detected in a symmetric arrangement which maintained constant geometry and a fixed ratio between the peak photon energy and the momenta of each member of the pair. The pion pair background was eliminated by observing the build up of showers from the pair members in a heavy plate spark chamber. Peak photon energies ranged from 600 MeV to 2000 MeV, corresponding to electron positron pair effective masses of 47 MeV to 202 MeV at the mean angles employed. The results show an excess of high effective mass pairs over what is expected from the Bethe Heitler formula. This result is consistent with a similar discrepancy found by a group at the Cambridge Electron Accelerator.
Dissert. Abstr.

N68-26050 Stanford Univ., Calif.
MUONIC MOLECULES AND NUCLEON-DEUTERON CAPTURE
Benjamin Perry Carter (Ph.D. Thesis) 1967 75 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-7902

Variational wave functions have been computed for all S states of muonic molecules involving hydrogen isotopes. Results for the pμd ground state have been used to compare nucleon-deuteron capture cross sections with pμd fusion rates. Using our molecular wave functions and the results of muonic molecule experiments, we estimate the low energy S wave cross section for the reaction $D(p,\gamma)He^3$. Our result is in disagreement with measurements in the tens-of-kilovolts region, but is consistent with thermal neutron-deuteron capture data when Coulomb effects are taken into account by means of the usual penetration factor. Finally, we re-examine the usual assumption that proton-deuteron capture occurs only from the doublet state, and show how the doublet and quartet matrix elements could both be determined from a new measurement of the total yield of gamma rays from pμd fusion in liquid hydrogen.
Dissert. Abstr.

N68-26051 Rochester Univ., N. Y.
A STUDY OF THE $C^{13}(He^3,D)N^{14}$ REACTIONS
Abdelmalak Mesak Bastawros (Ph.D. Thesis) 1967 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8947

In the present work, the mechanism of the (He^3,d) reaction was studied. C^{13} was chosen as a target to investigate the structure of N^{14} low lying levels. Eighty absolute cross-sections for deutron groups leading to the first five low lying states of N^{14} were measured. To examine variation of cross section with energy, an excitation function was measured. Elastic scattering of He^3 from C^{12} was also measured. The measurements were performed using a counter telescope system for particle identification. The observed cross sections were analyzed using distorted wave Born approximation formalism. Satisfactory agreement was found assuming that simple stripping is the dominant mechanism. An $l_p = 1$ capture was observed corresponding to transitions to the ground state, first and second excited state, and $l_p = 0$ for the 3rd excited state and an $l_p = 2$ for the 4th excited state. Dissert. Abstr.

N68-26055# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Servizio Documentazione.
PHOTODISINTEGRATION IN TWO BODIES OF He-4 OF ENERGY INTERVAL 500 $\leq E_\gamma \leq$ 750 MeV [FOTODISINTEGRAZIONE IN DUE CORPI DELL'He-4 NELL'INTERVALLO DI ENERGIA: 500 $\leq E_\gamma \leq$ 750 MeV]
M. Grilli, P. Picozza, C. Schaerf, R. Scrimaglio, F. Soso et al 28 Feb. 1968 9 p refs In ITALIAN *Its* Nota Interna No. 391
(LNF-68/6) CFSTI: HC $3.00/MF $0.65

Data are presented on the synchroton measurement of energy levels in the reaction: $\gamma + He^4 \rightarrow He^3 + n$ between 500 $\leq E_\gamma \leq$ 750 MeV. Also, information on the production of deuterons from helium in this energy range was obtained. The measurements of the reactions in this energy level, and previous experimental data suggest that an excited state of the α particle exists.
Transl. by F.O.S.

N68-26063 California Inst. of Tech., Pasadena.
NUCLEAR ENERGY LEVELS OF ^{37}K
David Reeves Goosman (Ph.D. Thesis) 1967 223 p
Available from Univ. Microfilms: HC $10.15/MF $3.00 Order No. 67-8454

Approximately forty levels in ^{37}K have been established via the reactions $^{40}Ca(p,\alpha)^{37}K$, $^{36}Ar(p,p)^{36}Ar$, $^{36}Ar(p,\gamma)^{37}K$, $^{36}Ar(p,p'\gamma)^{36}Ar$, $^{36}Ar(d,n)^{27}K$ and $^{36}Ar(^3He,d)^{37}K$. The analogues in ^{37}K to the first two excited levels in ^{37}Ar were found as a closely spaced doublet at 1368 and 1380 keV excitation energy. The half-life of the latter has been measured electronically to be 9.6 ± 1.4 nanoseconds. Spin and parity assignments have been made to seven of the lowest eight levels in this nucleus and to three higher levels. Approximate values for the elastic and inelastic proton and gamma-ray widths of several levels have been determined. Evidence for the positions and widths of two candidates for the first T = 3/2 level is presented. Calibrations of gamma-ray energies with Ge(Li) counters have made possible the determination of level energies with precisions ranging from one to five keV. The mass excess of the ground state is now known to three keV.
Dissert. Abstr.

N68-26112# Idaho Nuclear Corp., Idaho Falls.
REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE
M. S. Moore, comp. 1967 209 p refs Meeting held at Idaho Falls, Idaho, 17–18 Oct. 1967
(WASH-1079; EANDC(US)-104-U; INDC(US)-2-U) CFSTI: HC $3.00/MF $0.65

Progress in numerous investigations of neutron reactions and charged-particle reactions is summarized. Information, in varying degrees of completeness, is given on cross sections, resonance parameters, and level schemes. Some developments in instrumentation are also outlined.
NSA

N68-26119 Louisiana State Univ., Baton Rouge.
LATERAL AND ANGULAR STRUCTURE OF ELECTROMAGNETIC CASCADES
William Vernon Jones (Ph.D. Thesis) 1967 120 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-8785

Simultaneous measurements of the radial position and angular orientation of electrons in ten high energy electromagnetic cascades which were initiated by single γ-rays have been made. Six cascades having energies in the range 845–2000 BeV which were developed in large pure emulsion stack were measured up to the radial distance 2.1×10^{-2} r.l. from the cascade axis. Four cascades which were developed in a lead-emulsion sandwich stack were measured up to the radial distance 7.4×10^{-2} r.l. and these cascades had energies in the range 178–720 BeV. Numerical calculations of the angular distributions from cascade theory have been performed within approximation B and within the core approximation. A method has been presented for utilizing the energy determination from the angular distribution to establish the correct effective radiation length of a heavy sandwich stack. Dissert. Abstr.

N68-26124 Brown Univ., Providence, R. I.
ANALYSIS OF THE ELASTIC SCATTERING OF PROTONS AT HIGH ENERGY AND MOMENTUM TRANSFER USING THE SERBER MODEL AND BAKAMJIAN-THOMAS THEORY
David Avison (Ph.D. Thesis) 1966 90 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-2216

Serber's model for describing proton-proton scattering is investigated in detail at two laboratory momenta, 11.26 and 30.0 GeV/c. The two resulting momentum-transfer distributions obtained differ from those obtained by Serber, who used an optical approximation. Both curves are raised above Serber's in the high momentum-transfer region. The raising of these momentum-transfer curves in the high momentum-transfer region is due to the appearance of a real part in the low angular-momentum contributions to the scattering amplitude. The Bakamjian-Thomas theory is used to obtain relativistic scattering equations for the relative motion. Differences between these approaches are expected to show themselves mainly at large-angle scattering since the (unsquared) Bakamjian-Thomas Green's function differs appreciably from that of the Klein-Gordon equation only for small r. Dissert. Abstr.

N68-26154# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).
TWO PION PHOTOPRODUCTION IN A HYDROGEN BUBBLE CHAMBER BELOW 1000 MEV
S. De Schryver, L. Fiore, S. Focardi, G. Gialanella, V. Rossi et al 8 Apr. 1968 25 p refs *Its* Nota Interna No. 395
(LNF-68121) CFSTI: HC $3.00/MF $0.65

To obtain data on the photoproduction mechanism and formation of barionic and mesonic resonant states below 1000 MeV, hydrogen bubble chamber studies were made of the double photoproduction reaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$. The experimental apparatus is described, with details given on the circuitry for controlling the chamber expansion and the photographic apparatus, and for measuring the magnetic field and monitoring the incident photon flux. The pictures were taken with a photon beam intensity of about 300 equivalent quanta per pulse, corresponding to about 10 e^+e^- pairs per picture. Successively the intensity was increased by about a factor of 2. Preliminary data analysis indicates: (1) The main feature of the reaction below 1000 MeV is the very abundant formation of the $\Delta(1236)$ isobar in the doubly charged state (π^+p), due to the p_{33} wave in the (πN) interaction. (2) Comparison of experimental mass distributions with a suitable mixture of this reflection and phase space in previously calculated percentages confirms the abundant formation of the Δ^{++} isobar. There is no statistically significant evidence of the neutral $\Delta^0(\pi^-p)$ state in accordance with previous experimental results. M.G.J.

N68-26155# National Research Council of Canada, Ottawa (Ontario). Mechanical Engineering Div.
NUMERICAL SOLUTION OF THE THOMAS-FERMI EQUATION FOR POSITIVE VALENCE DIFFERENCES
R. F. Henry Dec. 1967 26 p refs
(NRC-MK-21; NRC-10011) CFSTI: $3.00

Analytical problems in the solution of the Thomas-Fermi equation are discussed and an iterative numerical method of solution is presented, together with suitable computer programs for its implementation. Author

N68-26164 California Univ., Berkeley.
GASEOUS THERMAL ELECTRON REACTIONS
Charles Edward Young (Ph.D. Thesis) 1966 98 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8678

We have employed a microwave cavity resonance technique to study the rate of disappearance of gaseous electrons in the presence of molecules which can capture them to form negative ions. Electron concentrations of 10^7 to 10^8 per cc were produced by photoionization of a small amount of NO with a single pulse of 1216Å or 1236Å light from microwave discharge in hydrogen or krypton, respectively. Experimental conditions also involved the presence of 1 to 100 torr of inert gas, which permitted the electrons to reach quickly a Maxwellian energy distribution corresponding to 300°K, and reduced the diffusional loss of electrons. Under these conditions, electron attachment to SF_6, C_7F_{14} and C_3F_8 was observed to correspond to a two body process with rate constants of 2.7×10^{-7}, 8.8×10^{-8} and 8.8×10^{-12} cc/molecule-sec, respectively. Attachment to C_2F_4 and SiF_4 appeared to be a three body process but estimation of rate constants was less accurate. The effectiveness of various inert gas molecules in producing three body attachment of electrons to NO was also investigated. Analysis of the data required us to correct for ambipolar diffusion but not for ion-electron recombination. Dissert. Abstr.

N68-26170 Minnesota Univ., Minneapolis.
PHOTO-EJECTION OF ELECTRONS FROM BUBBLE STATES IN LIQUID HELIUM 2
Jan Arwood Northby (Ph.D. Thesis) 1966 156 p
Available From Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-7764

We report here the observation of the photo-ejection of electrons trapped in bubble states in liquid helium. Detection of this effect offers very direct evidence of the validity of the bubble model. An electron which spends part of the time untrapped should have a higher average drift velocity in an electric field than one which remains in a bubble. We have used a time-of-flight apparatus to detect changes in the drift velocity of electrons when they are exposed to radiation in the one micron region. We measure an effective cross section as a function of light wavelength. Our experimental curves are compared with cross sections calculated for spherical square wells of various depths and radii. If we use the current experimental value of the well depth, we find agreement with theory if the bubble radius is either 14.90 ± 0.30 Å, or 20.55 ± 0.35 Å. These results are in reasonable agreement with previous theoretical and experimental estimates. The observed magnitude of the effect is also consistent with theory. Dissert. Abstr.

N68-26177*# National Aeronautics and Space Administration, Washington, D. C.
PROBLEMS OF EVALUATION OF DIFFERENTIAL ANGULAR CORRELATION MEASUREMENTS WITH A FOUR-DETECTOR APPARATUS AND INVESTIGATIONS WITH YB-172 . [AUSWERTEPROBLEME BEI EINER VIER-DETEKTOR-APPARATUR ZUR DIFFERENTIELLEN MESSUNG VON WINKELKORRELATIONEN UND MESSUNGEN AM YB 172]
H. F. Wagner Jun. 1968 43 p refs Transl. into ENGLISH from BMWF-FBK-66-39 Rept.
(NASA-TT-F-11320; BMWF-FBK-66-39) CFSTI: $3.00 CSCL 20H

Formulas for differential angular correlation measurements are derived and discussed. The formulas are applied to the problem of a four-detector apparatus, using a digital computer program. The fully transistorized automatic control of the apparatus is described in detail, with discussion of differential measurements of the 203 - 1095 keV cascade of Yb^{172}. As result, $A_2(0) = -0.085 \pm 0.021$; $A_4(0) = +0.003 \pm 0.025$ are given, with $T_{1/2} = (8.34 \pm 0.20)$ ns for the 1174 keV level. Author

N68-26191 Brown Univ., Providence, R. I.
R-MATRIX THEORY FOR ELASTIC AND REACTIVE MOLECULAR SCATTERING
Byung Chan Eu (Ph.D. Thesis) 1968 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-2235

In this thesis we investigate some applications of the R-matrix theory of Wigner and Eisenbud to molecular scattering problems.

In the elastic scatterings of molecules of low energy resonances due to metastable (quasi-bound) states of the collision complex may occur. These metastable states correspond to trapped molecules in the effective potential well. The resonance cross sections are given in terms of the R-matrix and approximate methods of calculating level widths and level shifts are given. Next we present a derivation of the rate coefficient expression in the transition state theory of chemical reactions of Wigner, Polanyi, and Eyring; we use the bimolecular reaction rate expression in the collision theory which is given in terms of the total reaction cross section. We proceed with a derivation of a statistical theory of reactive collisions starting from the exact R-matrix formalism. Finally we discuss briefly the use of the Kapur-Peierls theory in our derivations. Dissert. Abstr.

N68-26236# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).

DIRAC SPINORS, COVARIANT CURRENTS AND THE LORENTZ GROUP OVER A FINITE FIELD

E. G. Beltrametti and A. A. Blasi 1968 23 p refs

(RT/FI(68)6) CFSTI: HC $3.00/MF $0.65

The proper Lorentz group is extended through the improper transformations and the four-dimensional representations, leading to Dirac spinors over a finite field, are examined. In the continuous case, the standard finite-dimensional representations of the Lorentz group, and in particular the one transforming Dirac spinors, satisfy the physical requirements of becoming unitary when restricted to the compact three-dimensional rotation group. For the finite geometry case, a method is described for recovering unitarity by letting the representation become a ray representation. It is shown that in the finite Lorentz group two inequivalent spinor representations occur; therefore, two kinds of Dirac fields are possible. Also treated are the properties displayed by bispinor sesquilinear forms, such as the ones occurring in weak-interaction Hamiltonians, when covariance is demanded with respect to the finite version of the Lorentz group. A.L.

N68-26237 Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).

KINEMATICAL CONSTRAINTS, FACTORIZATION AND KINEMATICAL ZEROS

P. Di Vecchia, F. Drago, and M. L. Paciello 28 Feb. 1968 19 p refs *Its* Nota Interna No. 390

(LNF-68/5) CFSTI: HC $3.00/MF $0.65

The kinematical constraints at t = 0 are derived for an important class of reactions. The factorization requirements for the Regge pole residue functions are studied. The "minimal" behaviour at t = 0 of the Regge residue functions, consistent with the kinematical constraints and the factorization, is given. The results are compared with those obtained in the group theoretical approach. Author

N68-26304# Oak Ridge National Lab., Tenn.

ABSOLUTE MEASUREMENT OF THE ACTIVITY OF THRESHOLD DETECTORS AND EVALUATION OF THE FAST-NEUTRON FLUX IN THE CORE

V. Kadlec, P. Otopal, and M. Vitak [1967] 55 p refs Transl. into ENGLISH of Cesk. Akad. Ved, Rez Rept. UJV-1547

(ORNL-TR-1843; UJV-1547) CFSTI: HC $3.00/MF $0.65

The absolute fast neutron flux is determined on the assumption that the measurement was made in a spectrum corresponding to the fission spectrum with an energy of 2 MeV. The selected set of detectors which is suitable for measuring the fast neutron spectra calibration is carried out. All the absolute measurements are based on the absolute measurement of the ^{32}P activity. Author (NSA)

N68-26308# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.

OBSERVATION OF THE $\phi \rightarrow e^+e^-$ DECAY

R. G. Astvatsaturov, M. A. Azimov, A. M. Baldin, A. S. Belousov, I. V. Chuvilo et al 1968 11 p refs Submitted for publication

(JINR-E1-3770)

Five events of the $\phi \rightarrow e^+e^-$ decay were identified using spark chambers and Cerenkov total absorption gamma spectrometers. The probability for these events to be simulated by the background is smaller than 0.1%. The new data on the e^+e^- decays of ρ and ω-mesons were obtained. Author (NSA)

N68-26318# Yeshiva Univ., New York. Belfer Graduate School of Science.

MODULAR VARIABLES IN QUANTUM THEORY Final Report, Jun. 1, 1965–May 31, 1965

Yakir Aharonov and Aage Petersen Nov. 1967 54 p refs

(Contract AF 19(628)-5143)

(AFCRL-68-0127; AD-668099)

The non-local aspects of interaction between quantum systems are investigated. These aspects are particularly conspicuous in quantum phenomena without a classical analog, such as the quantum effects of electromagnetic potentials. The study of the potential effect leads to the introduction of a new type of dynamical variables, modular variables, which are suitable to express the physical features of the quantum mechanical non-locality. The potential effect is reviewed and the question of whether the effect can be described as an exchange of otherwise conserved dynamical quantities is discussed. It is shown that this can be done in terms of modular momentum. Some fundamental properties of modular variables are investigated. In particular it is demonstrated that for these variables the quantum equations of motion are essentially different from the classical ones, and that modular momentum may commute with modular position. It is shown how the peculiar properties of modular momentum enable us to predict new quantum effects with no classical analog, such as radiationless acceleration of charged particles. The concept of modular energy is introduced and its usefulness is shown by suggesting new interesting quantum effects. The two-slit electron interference experiment is discussed in terms of modular momentum. Some further applications of modular variables are outlined, and the difference between classical and quantum mechanical non-locality is considered. TAB

N68-26356# Gulf General Atomic, San Diego, Calif.

DIFFERENTIAL NEUTRON THERMALIZATION Final Report

W. L. Whittemore 1 Nov. 1967 112 p refs

(Contract AT(04-3)-167)

(GA-8283) CFSTI: HC $3.00/MF $0.65

A neutron velocity selector was used to study the details of neutron scattering in reactor-grade graphite, in liquid D_2O, and in BeO. The scattering into various angular directions between 30 and 150° was studied for incident neutrons with energies ranging up to ≈0.7 eV. The energy-transfer cross sections, corrected for plural scattering effects, are evaluated to provide data in regions of large energy and momentum transfers not previously available and not readily accessible to experimenters using a reactor as a source of neutrons. The results for D_2O and graphite are quite definitive and, when compared to the best available theories, indicate some regions of good agreement and some regions where better theoretical treatment may be needed. The results for BeO are preliminary but agree reasonably well with previous experimental results. Author (NSA)

N68-26359# Brookhaven National Lab., Upton, N. Y.

IMPORTANCE OF THE CORRECT TREATMENT OF THE SCATTERING INTEGRAL IN THE BOLTZMANN EQUATION IN DEEP PENETRATION CALCULATIONS IN IRON

J. J. Wagschal, M. M. Levine, and J. Chernick [1967] 24 p refs Presented at the Spec. Ann. Meeting of the Israel Phys. Soc., Jerusalem Sponsored by AEC

(BNL-12322; CONF-680412-1) CFSTI: HC $3.00/MF $0.65

In the calculation of the deep penetration of neutrons in iron slabs the question of how many terms should be kept in the

Legendre polynomial expansion of the scattering integral in the Boltzmann equation comes up. Experience in reactor calculations showed that there is practically no difference in either critical mass or neutron spectrum between calculations or order $L \geq 2$ in the scattering integral. Even the transport approximation and the $L = 1$ approximation have been within 0.5% of the higher approximations. The propagation of neutrons through many mean free paths of an anisotropically scattering medium is found to be much more sensitive to the number of terms in the expansion. S16 calculations have been performed for the penetration of neutrons from a plane source through thick slabs of iron using different L approximations. Author (NSA)

N68-26361# Comitato Nazionale per l'Energie Nucleare, Frascati (Italy).

HIGH ENERGY PHOTODISINTEGRATION OF HE^3

G. Goggi, A. Piazzoli, P. Picozza, D. Scannicchio, C. Schaerf et al 18 Mar. 1968 7 p refs Submitted for publication /its Nota Interna No. 393

(LNF-68/14) CFSTI: HC $3.00/MF $0.65

Preliminary results are reported on the two-body photodisintegration of helium 3 in the γ energy region about the first pion–nucleon resonance. The differential cross section for the reaction $\gamma + He^3 \rightarrow P + D$ was measured for $E_\gamma = 180$–550 MeV at the center of mass angle of 90°. The most relevant feature of the data obtained is considered to be the absence of any resonant behavior in the region of the first pion–nucleon resonance. M.G.J.

N68-26387# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

GAMMA-RAY SPECTRUM FROM THE RADIATIVE CAPTURE IN Cs [GAMMA-SPEKTR IZ RADIATSIONNOGO ZAKHVATA NA Cs]

F. Bechvarzh, Ya. Vrzal, Ya. Liptak, and Ya. Urbanec 1968 14 p refs In RUSSIAN Submitted for publication

(JINR-P3-3697)

The measurements of the γ-ray spectra, following the resonance neutron capture in ^{133}Cs, performed with the aid of the Ge(Li) detector of active volume about 12 cm^3, are described. The energies and intensities of a number of transitions have been obtained. Author (NSA)

N68-26388# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

A MODEL OF THE LEE FIELDS [MODEL POLEI LI]

A. V. Efremov 1968 14 p refs In RUSSIAN; ENGLISH summary

(JINR-P2-3731)

It is shown that, for the Lee fields of an arbitrary tensor and isotopic structure, the spectral condition leads to the absence of the scattering. For a special case of the vector fields $S = 1$. Author (NSA)

N68-26389# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

γ-RAY SPECTRA FROM THE RESONANCE NEUTRON CAPTURE IN Ba AND Pr [SPEKTRY γ-LUCHEI IZ ZAKHVATA REZONANSNYKH NEITRONOV NA IZOTOPAKH Ba I Pr]

F. Bechvarzh, Ya. Vrzal, Ya. Liptak, and Ya. Urbanec 1968 25 p refs In RUSSIAN Submitted for publication

(JINR-P3-3696)

With the help of a high-resolution spectrometer, the γ-ray spectra following the neutron capture in ^{138}Ba and ^{141}Pr were measured. On the basis of the results obtained, conclusions were drawn about the character of intensive primary transitions for the 24.5-eV resonance of ^{138}Ba and about the character of the resonances in ^{141}Pr as well. Author (NSA)

N68-26390# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.

OBSERVATION OF THE Po AND At ISOTOPES IN THE FISSION FRAGMENTS WHEN BOMBARDING ^{238}U WITH THE ^{20}Ne AND ^{40}Ar IONS [NABLYUDENIE IZOTOPOV POLONIYA I ASTATINA V OSKOLKAKH DELENIYA PRI OBLUCHENII ^{238}U IONAMI ^{20}NE I ^{40}AR]

I. V. Kuznetsov, N. S. Mal'tseva, Yu. Ts. Oganesyan, A. M. Sukhov, and V. A. Shchegolev 1968 15 p refs In RUSSIAN Submitted for publication

(JINR-P7-3710)

The yields of the $^{204,206,208,210}Po$ and the $^{207,209,211}At$ isotopes are measured in the fission fragments when bombarding ^{238}U with the ^{20}Ne and ^{40}Ar ions. The control experiments exclude the possibility of production of the mentioned isotopes in stripping reactions. The data are given on the production of the ^{211m}Po and ^{212m}Po isomers in the fission fragments. The experimental data are discussed from the point of view of the cascade fission. The possibility of the isotope synthesis in stripping reactions is pointed out. Author (NSA)

N68-26391# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

ON THE OBSERVANCE OF THE CONSERVATION LAWS IN AN ELEMENTARY ACT AT THE INTRANUCLEAR CASCADE CALCULATION [O VYPOLNENII ZAKONOV SOKHRANENIYA V ELEMENTARNOM AKTE PRI RASCHETAKH VNUTRIYADERNOGO KASKADA]

N. M. Sobolevskii and V. D. Toneev 1968 9 p refs In RUSSIAN Submitted for publication

(JINR-P4-3714)

Simulation of inelastic πN and NN interactions when calculating the fast particle collisions with the nuclei by the cascade model involves some difficulties. One of them is an exact account of the laws of energy and momentum conservation when the characteristics of an elementary act are sampled from the known experimental angular and energy distributions of the produced particles. The problem is considered, as to what degree the exact account of the law of energy conservation only (in the "equivalent" system) effects the elementary act characteristics and the results of calculation of inelastic nucleon–nucleus interactions. Author (NSA)

N68-26422# Brookhaven National Lab., Upton, N. Y.

PARTICLE PRODUCTION IN HIGH ENERGY PROTON–PROTON COLLISIONS

Frank Turkot [1968] 34 p refs Presented at the Topical Conf. on High Energy Collisions of Hadrons, Geneva, 15–18 Jan. 1968 Sponsored by AEC

(BNL-12232; CONF-680103-6) CFSTI: HC $3.00/MF $0.65

The well-established experimental features of particle production in p + p collisions in the 5 to 30 GeV region are briefly reviewed. Then recent bubble chamber and counter-spark chamber data are surveyed. Various models proposed and used to fit these data are mentioned. It is found that only the gross features are known, and the basic mechanism of particle production is still obscure. NSA

N68-26434# European Organization for Nuclear Research, Geneva (Switzerland).

CERN DOCUMENTS ON THE GENERAL PROBLEM OF EJECTION: BIBLIOGRAPHY [LES DOCUMENTS DU CERN RELATIFS AU PROBLEME GENERAL DE L'EJECTION: BIBLIOGRAPHIE]

J. Fronteau 16 May 1967 44 p refs In FRENCH

(NP-17329) CFSTI: HC $3.00/MF $0.65

A list of 293 documents on beam transport and extraction for the CERN synchrotron, synchrocyclotron, the proposed 300-GeV proton synchrotron, and the proposed intersecting storage rings is presented. NSA

N68-26446# Naval Radiological Defense Lab., San Francisco, Calif.
IDENTIFICATION AND YIELD OF Pd-117 IN THE THERMAL-NEUTRON FISSION OF U-235
Herbert V. Weiss, Johnny L. Elzie, and James M. Fresco 12 Feb. 1968 14 p refs
(Contract AT(49-2)-1167)
(USNRDL-TR-68-25; AD-668022)

As part of a study of nuclear charge distribution in the region of symmetric fission, the existence and cumulative fission yield of 117Pd were sought. Palladium was isolated free from silver and cadmium at different times after fission and the quantity of descendant 117Cd activity was measured. A half-life for 117Pd of 5.0 +0.5 or -0.7 sec was derived from these data. Through a comparison of 117Cd activity produced by 117Pd with the total 117Cd activity produced by all isobars, a cumulative fractional chain yield of 0.682 was computed for 117Pd. From this yield the most probable nuclear charge (Zp) for the 117-mass chain was estimated. Author (TAB)

N68-26447# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
SCALAR MESON WIDTHS
L. Miku 1968 10 p refs Submitted for publication
(JINR-E2-3730)

The widths of scalar mesons are evaluated in the approximation of soft-meson emission, assuming that the equal-time commutator between an axial charge and an axial divergence is proportional to scalar meson fields. Author (NSA)

N68-26448# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
TEST OF CROSS-SECTION SUM RULES FOR NUCLEON MAGNETIC MOMENTS
K. Levin 1968 13 p refs Submitted for publication
(JINR-E2-3715)

Considering forward Compton scattering by nucleons and deuterons and approximating the deuteron by the free nucleons above the pion production threshold, the three cross section sum rules for the nucleon and deuteron magnetic moments are combined in a relation containing only known constants and a low-energy integral which agrees with the predicted value. The result concerning the validity of the sum rules supports other tests by Gerasimov, Drell, and Hearn and Pagels based on pion photoproduction data below 1 GeV. Author (NSA)

N68-26457# Princeton Univ., N. J. Palmer Physical Lab.
NUCLEAR POLARIZATION IN MUONIC ATOMS
Min-Yi Chen (Ph.D. Thesis) Jan. 1968 99 p refs
(Contract AT(30-1)-937; Grant NSF GP-579)
(PUC-937-291) CFSTI: HC $3.00/MF $0.65

The nuclear polarization effect in muonic atoms is calculated for ^{208}Pb, ^{40}Ca, and ^{238}U. The nuclear intermediate states of ^{208}Pb are collective particle-hole states calculated from realistic nucleon–nucleon forces. The total effect is an increase of binding of 5.5 to 6.5 keV for the 1s level and 2.0 keV for the 2p level. The uncertainty comes from the lack of knowledge of 0^+ breathing excitations. Similar calculations for ^{40}Ca give the correction to the 1s level as ≈0.2 keV. Henley and Cooper's closure approximation, which leads to a large correction of 58 keV to the ^{208}Pb 1s level, is repeated with two improvements: the intermediate muonic states in the continuum are treated properly and the two nucleon cross terms in the ground state nucleus are included. The correction then comes down to the same order of magnitude. The rigid rotator model is used for the deformed ^{238}U. The correction to the 1s level from the quadrupole coupling with low-lying rotational nuclear states and d muonic states is 6.4 keV. For the $2p_{1/2}$ level, the correction from muonic intermediate states outside of the spin doublet $2p_{1/2}$–$2p_{3/2}$ is 1.9 keV. In all cases the continuous spectrum of the muon contributes most of the correction. The reference spectrum method is used throughout the calculation. Author (NSA)

N68-26458# Princeton Univ., N. J. Palmer Physical Lab.
QUARKS, SYMMETRIES, AND GROUPS: A SURVEY FOR PEDESTRIANS
Harry J. Lipkin Jan. 1968 20 p refs Presented at the 5th Conf. on Symmetry Principles at High-Energy, Coral Gables, Fla.
(Contract AT(30-1)-937)
(PUC-937-294; CONF-680110-1) CFSTI: HC $3.00/MF $0.65

The survey of quarks, symmetries, and groups cover symmetries at high energies, wrong symmetries, rules for the quark model, relativistic quark models, and properties of quarks. NSA

N68-26467# Joint Inst. for Nuclear Research, Dubna (USSR).
TO THE PROBLEM OF THE STABILITY OF SUPERHEAVY NUCLEI [K VOPROSU O STABIL'NOSTI SVERKHTYAZHELYKH YADER]
Yu. A. Muzychka, V. V. Pashkevich, and V. M. Strutinskii 1968 11 p refs In RUSSIAN Submitted for publication
(JINR-P7-3733)

Shell corrections and the deformation energies for a number of superheavy nuclei were calculated. Author (NSA)

N68-26476# Princeton Univ., N. J. Elementary Particles Lab.
STUDY OF THE DECAY $K_2^* \rightarrow 2\pi^*$ Technical Report, Jun. 1965–Mar. 1968
Tuneyoshi Kamae 26 Mar. 1968 133 p
(Contract N0014-67-A-0151-001)
(TR-45; AD-668988)

The ratio between the two decay rates, Gamma(neutral-K2 to 2 neutral-pions)/Gamma(neutral-K1 to 2 neutral-pions), was studied by comparing the 2 neutral-pions decays in the neutral-K2 beam to those in the regenerated neutral-K1 beam. The advantage of this method is that the result is insensitive to detection efficiency. No free decays neutral-K2 to 2 neutral-pions were observed above the 3 neutral-pion background. On the other hand, 2 neutral-pions decays of neutral-K1 produced in the tungsten regenerator were clearly observed. The comparison of the free decay data with the regeneration data leads to the upper limit of 0.000009 for this ratio. Author (TAB)

N68-26477# Stanford Univ., Calif. High-Energy Physics Lab.
ASYMMETRIC PHOTOPRODUCTION OF MUON PAIRS OFF HYDROGEN AS A TEST OF QUANTUM ELECTRODYNAMICS
Daniel James Quinn Apr. 1968 142 p refs
(Contract Nonr-225(67))
(HEPL-534; AD-668169)

The paper describes an experiment, performed at the Stanford Mark III electron linear accelerator, which measured the differential cross section for the asymmetric photoproduction of muon pairs from a hydrogen target, gamma-ray + p to negative-muon + positive-muon + p. The negative-muon was detected under conditions where the positive-muon and proton were non-relativistic in the laboratory. The experiment was performed as a test of quantum electrodynamics. Author (TAB)

N68-26484# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
MEASUREMENTS ON INELASTIC ELECTRON-PROTON SCATTERING
F. W. Brasse, J. Engler, E. Ganssauge (Marburg Univ.), and M. Schweizer (Hamburg Univ.) Nov. 1967 46 p refs
46 p refs
(DESY-67/34)

The cross section for inelastic electron proton scattering has been measured by detecting the scattered electron alone and by detecting the electron in coincidence with the proton. Data without coincidence were taken at scattering angles of 47.5, 55, and 75° for momentum transfers to the pion nucleon system of 20 and 40 f^{-2} at the first resonance (W = 1236 MeV). One measurement at 32.2° and 40 f^{-2} and one at 47.5° and 60 f^{-2} is also reported. The W was varied for fixed primary energy from 938 to about 1400 MeV. At the first resonance the cross sections are compared with results of other laboratories as well as with theoretical predictions based both on symmetry groups and dispersion relations. For the latter case there is quite good agreement with the measurements. In the region of the second and third classical resonance cross sections do not agree with the threshold behavior of the resonant parts in this region of momentum transfer. Author (NSA)

N68-26486# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

THE PROBLEMS OF NONEQUIVALENT REPRESENTATIONS OF CANONICAL COMMUTATION RELATIONS IN QUANTUM FIELD THEORY

A. V. Astakhov, O. I. Zav'yalov, and A. D. Sukhanov 1967 27 p refs In RUSSIAN
(ITF-67-39)

A number of problems on nonequivalent representations of c.c.r. Hagg's theorem, its consequences and mathematical aspects of the problem are discussed from a certain point of view. The difference between unitary and canonical transformations is considered as exemplified by quadratic-Lagrangian models. It is shown that when using nonequivalent representations of c.c.r., the canonical transformations in a usual Hilbert space can be extended to unitary ones in a nonseparable Hilbert space. The realistic of field theory describing the field renormalization is used to show that similar possibilities can be realized in the exact field theory as well. Author (NSA)

N68-26506# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.

DESIGNATION OF INVARIANCE AMPLITUDES OF INTERACTION OF PARTICLES WITH ARBITRARY SPINS [O POSTROENII INVARIANTNYKH AMPLITUD VZAIMODEISTVIYA CHASTITS S PROIZVOL'NYMI SPINAMI]

M. S. Marinov 1967 55 p refs In RUSSIAN
(ITEF-538)

A method to construct phenomenological amplitudes for arbitrary interactions of particles with any spin is presented. The relativistic particle wave functions are taken in the 2 ± (2s + 1)-component (for spin s) bispinor representation. The vertex functions and the two-body scattering amplitudes are considered in some detail. The method is suitable for considerations of the analytical properties, unitarity, the Feynman graphs, the discrete symmetries, as well as to calculate observable quantities and to fulfil the phase shift analysis. Author (NSA)

N68-26517 California Inst. of Tech., Pasadena.

PHOTOPRODUCTION OF CHARGED PION PAIRS AND N* (1238) IN HYDROGEN FROM 0.9 TO 1.3 GEV

Michael George Hauser (Ph.D. Thesis) 1967 217 p
Available from Univ. Microfilms: HC $9.90/MF $3.00 Order No. 67-8456

The momentum spectrum and angular distribution of negative pions produced in the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ have been measured at eight incident photon energies from 0.9 to 1.3 GeV. The reaction was produced in a liquid hydrogen target illuminated by a bremsstrahlung beam from the Caltech synchrotron. Negative pions were detected and momentum analyzed with a magnetic spectrometer employing a combination of scintillation counters and Cherenkov counters. The incident photon energy was fixed by using the technique of bremsstrahlung subtraction. The cross section for the pseudo-two-body reaction $\gamma + p \rightarrow \pi^- + N^*(1238)^{++}$ was obtained by fitting the π^- momentum spectrum at each angle and energy with a linear combination of a resonance term and a three-body phase space term. The angular distribution of the π^- in N^* production is in good qualitative and fair quantitative agreement with predictions of the Drell model. Gauge invariant models are in poorer agreement with the data. Dissert. Abstr.

N68-26518# Atomic Energy Commission Research Establishment, Riso (Denmark). Physics Dept.

PARITY-NON-CONSERVATION IN NUCLEAR FORCES STUDIED BY THE CAPTURE OF POLARIZED THERMAL S-NEUTRONS

Elisabeth Warming Sep. 1967 34 p refs
(RISO-167)

The asymmetry A in the γ intensity after the capture of polarized thermal s-wave neutrons in ^{113}Cd was investigated with a view to searching for a parity-nonconserving nuclear force. The upper limit for A was determined at $|A| < 4.7\ 10^{-4}$. Author (NSA)

N68-26519# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

SHADOW ELASTIC SCATTERING IN THE MULTI-REGGE-EXCHANGE MODEL

L. Michejda, J. Turnau (Jagellonian Univ.), and A. Bialas (Jagellonian Univ.) 1968 10 p refs
(INR-880/VI/PH)

Shadow elastic scattering in the multi-Regge-exchange model of Ohan et al. is estimated. The necessity of introducing the momentum-transfer-dependent phases is pointed out. Author (NSA)

N68-26522# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.

REGGE ON DIAGRAM TECHNIQUE [REDZHIONNAYA DIAGRAMNAYA TEKHNIKA]

V. N. Gribov 1967 37 p refs In RUSSIAN; ENGLISH summary
(IEF-511)

Based on the investigation of the Feynman graphs asymptotic behavior at high energy and fixed momentum transfer the graph technique is formulated to consider the branch points in the angular momenta complex plane. Using this technique the reggeon is described as a nonrelativistic particle characterized by two-dimensional momentum k. The pole trajectory $\alpha(k^2)$ plays the role of energy and the momentum j—the role of frequency. The situation appears when describing the diffraction cone assuming the existence of the Pomeranchuk pole is discussed. Author (NSA)

N68-26523# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

ASYMMETRY MOMENTS OF ANGULAR DISTRIBUTIONS

P. Kielanowski and J. Werle 1967 11 p refs
(INR-868/VII/PH)

The conventional harmonic analysis of the experimental angular distribution function requires cumbersome integrations with suitable weight functions. A much simpler analysis of the experimental data with the help of asymmetry moments is proposed. It is shown that the value of a suitable asymmetry moment may be used as a parity or spin test. Author (NSA)

N68-26525# Utrecht State Univ. (Netherlands).

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE ^{40}Ca LEVEL SCHEME

Hendrik Pieter Leenhouts (Ph.D. Thesis) 1967 53 p refs
(NP-17384)

In the proton energy range E_p = 500 to 2900 keV, fifty-three resonances were observed in the $^{39}K(p,\gamma)^{40}Ca$ reaction. The

resonance energies and strengths were determined. The decay modes of most of the resonances and of fifteen lower excited states in ^{40}Ca were determined from single and coincidence gamma-ray spectra. Gamma–gamma triple angular correlation measurements were performed at eight resonances, and polarization experiments at three resonances of the $^{39}K(p,\gamma)^{40}Ca$ reaction in the proton energy range E_p = 1.1 to 2.1 MeV. Spins and parities could be determined of the following ^{40}Ca levels (energies in MeV): 3.73, 3^-; 3.90, 2^+; 4.48, 5^-; 5.24, 2; 5.27, 4^+; 5.61, 4^-; 6.28, $3^{(-)}$; 6.94, (1, 2); 7.29, 0; 7.49, 2; 9.41, 2; 9.61, 3^+; 9.65, 2^-; 9.79, 3; 9.87, 1; 9.96, 4^+; and 10.33 1. In addition, a number of gamma-ray multipole mixing ratios in ^{40}Ca were determined. A shell model calculation was made with the surface delta interaction to explain the odd-parity levels. Author (NSA)

N68-26541# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
ELECTROMAGNETIC FORM FACTORS OF NUCLEONS IN THE MODEL OF QUASI-INDEPENDENT QUARKS [ELEKTROMAGNITNYE FORMFAKTORY NUKLONOV V MODELI KVAZINEZABISIMYKH KVARKOV]
V. P. Shelest 1967 13 p refs In RUSSIAN
(ITF-67-52)

In the framework of the model of quasi-independent quarks with switched-off interaction the form baryon electromagnetic current is obtained, which implies a relation between nucleon electric and magnetic form factors, confirmed by experiment. Author (NSA)

N68-26543# Princeton Univ., N. J. Palmer Physical Lab.
GROUPS, SYMMETRIES AND QUARKS. PART 1: GROUPS AND SYMMETRIES
Harry J. Lipkin Feb. 1968 34 p refs
(Contract AT(30-1)-937)
(PUC-937-304) CFSTI: HC $3.00/MF $0.65

The discussion of groups, symmetries, and quarks includes space–time and internal symmetries, some general remarks on the use of group theory in particle physics, and an example of how the pedestrian approach might be used in discussing the Lorentz group. A symmetry generator with explicit time dependence, G-spin in a simple time-dependent Lie algebra, the structure of G-spin multiplets, G-spin multiplets in Dirac spinor notation, mass spectra in spinor space, and larger time-dependent Lie algebras are also discussed. NSA

N68-26545# Soreq Research Establishment, Israel Atomic Energy Commission, Yavneh.
NUCLEAR DATA FOR PLUTONIUM-240, PLUTONIUM-241 AND PLUTONIUM-242
S. Yiftah, J. J. Schmidt (Kernforschungszentrum), M. Caner, and M. Segev Dec. 1967 100 p refs Sponsored in part by Kernforschungszentrum, Karlsruhe, West Ger.
(IA-1152)

An evaluation of the basic nuclear data for ^{240}Pu, ^{241}Pu, and ^{242}Pu in the range 0.01 eV to 15 MeV was made. Partial cross sections are constructed for the thermal and fast neutron ranges; they are presented in graphical and tabular form. Resonance parameters and average parameters are recommended for the resonance region; they are presented in tabular form. The cross sections constructed are: total, nonelastic, elastic scattering, radiative capture, fission, total and partial inelastic scattering, (n,2n), and (n,3n). Other nuclear data considered are: the average parameters above 1 keV, the average number of prompt neutrons per neutron-induced fission, the average scattering cosine in the lab system, and the energy spectrum of secondary neutrons from fission. Author (NSA)

N68-26546# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
SOME PROBLEMS OF THE HAMILTONIAN AND LAGRANGIAN FORMALISMS IN QUANTUM FIELD THEORY
S. V. Svechnikov and A. D. Sukhanov 1967 40 p refs In RUSSIAN
(ITF-67-42)

A number of problems of the Hamiltonian formalism, unsolved so far are solved by a modification of the latter. The Dyson images of Heisenberg operators are obtained in the pure renormalization model and in the exact pseudoscalar theory. The unitarity problem for the S-matrix ordinary form in renormalized theories and the problem of determining the powers of Heisenberg operators. Lehmann's class of theories as well as some other problems are discussed from the Hamiltonian point of view. Author (NSA)

N68-26555# Bettis Atomic Power Lab., Pittsburgh, Pa.
DAFTI: A FORTRAN PROGRAM FOR LEAST SQUARES FITTING OF 0.0253 EV NEUTRON DATA FOR FISSILE NUCLIDES
D. R. Harris Feb. 1968 21 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-761) CFSTI: HC $3.00/MF $0.65

A FORTRAN IV program DAFT1 for weighted least squares fitting of 0.0253-eV neutron data for fissile nuclides is described. The program also carries out computations relevant to discerning overall goodness of fit, particularly deviant data, and data whose improvement would lead to large reductions in error of each fitted parameter. Author (NSA)

N68-26556# California Univ., La Jolla.
QUASI-PARTICLE DESCRIPTION OF 2^+ AND 3^- STATES OF EVEN–EVEN SPHERICAL NUCLEI
R. J. Lombard 1967 35 p refs
(PINO/TH-114) CFSTI: HC $3.00/MF $0.65

The description of the first 2^+ and 3^- level of spherical nuclei $90 \leq A \leq 150$ and $186 \leq A \leq 206$ is performed in the framework of the BCS theory. The residual interaction is taken as the superposition of the pairing force and of the multipole force. The shortrange proton–neutron correlations are neglected. In addition to the valence nucleons, the core particles are taken into account; it allows the computation of the transition probabilities without any effective charge. Theoretical predictions concerning the E_{2+} and E_{3-} energies, the B(E2) and B(E3) reduced transition probabilities and the gyromagnetic factors g_{2+} are in good agreement with experiment. Author (NSA)

N68-26557# Stanford Univ., Calif. Linear Accelerator Center.
ION LOSS BY ELECTRON SCATTERING IN COMPRESSED ELECTRON RINGS
R. H. Helm Feb. 1968 6 p Presented at the Conf. on Stability of Electron Rings, Berkeley, Calif., 29 Jan.–10 Feb. 1968
(SLAC-PUB-386; CONF-680111-1) CFSTI: HC $3.00/MF $0.65

The heating by electron scattering on the ions trapped in a compressed electron ring can in principle lead to ion energies sufficient to permit escape from the potential well. A correct treatment of this question presumably would include the effects of random and systematic fluctuations in electron density, in which many particles might act collectively in exciting the ions. The purpose of the present note is to investigate the much simpler problem in which the ring is assumed to be uniform and quiescent, and the scattering events are assumed to be random and uncorrelated. Three separate processes are considered: single scattering, in which the recoil from one large-angle scattering event imparts escape momentum to the ion; azimuthal drag, in which the recoils from many small-angle events result in a cumulative tangential acceleration of the ions; and random walk, or statistical accumulation of impulses normal to the electron velocity. Under typical conditions

for the electron ring accelerator (ERA) these processes all lead to insignificant losses of protons (lifetimes much greater than one second). In the case of highly ionized heavy ions, the random walk and azimuthal drag effects could have lifetimes on the order of the ionization time. Author (NSA)

N68-26558# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.

CALCULATION OF DOPPLER FUNCTIONS $\psi(\theta,x)$; $\chi(\theta,x)$; $J(\theta,\beta)$ AND $J(\theta,\beta,i)$ [VYPOCET DOPPLEROVYCH FUNKCI $\psi(\theta,x)$; $\chi(\theta,x)$; $J(\theta,\beta)$ A $J(\theta,\beta,i)$]

J. Stepanek Dec. 1967 72 p refs In CZECH; ENGLISH summary
(UJV-1932)

The simplest method for the calculation of Doppler function is described from the point of view of time calculation. In the first part Doppler functions $\psi(\theta,x)$ and $\chi(\theta,x)$ are described, which were introduced by Voigt. With the help of these functions the energy dependence of the absorption as well as the scattering of neutrons in an isolated resonance of the absorber is described. Calculation of these functions is divided into two regions for $x \geq A/\theta$ and $x < A/\theta$, where for practicable accuracy 10^{-4} is $A = 7.3$. In the $x \geq A/\theta$ region for calculation of the function $\psi(\theta,x)$ and $\chi(\theta,x)$, an asymptotic relation is used in the form of the infinitive sum; in the second region for $x < A/\theta$, an analytic method was chosen which had been described by Dandieu, Gautier, Guillermin, Olivier, and Roche. In this work functions $T(\theta,x)$ and $\chi(\theta,x)$ are calculated using a sum in which the first members depend on $\psi(\theta,0)$. This method is compared with the Reichels' method which uses Hermite polynomials and with that of Buckler and Pull. Tables of the $\psi(\theta,x)$ and $\chi(\theta,x)$ functions are also produced for $\theta = 0.001, 0.005, 0.01, 0.05, 0.1, 0.5$, and 1 and $x = 0$ to 900. In the second part, Doppler functions $J(\theta,\beta,i)$ and $J(\theta,\beta)$ are described. For their calculation the Wijngaardens' method is taken. An effect of interference scattering in dependence on i, β, and θ was compared. The $J(\theta,\beta)$ function was also approximated with a maximum relative error $<6.10^{-4}$. Author (NSA)

N68-26560 Brown Univ., Providence, R. I.

LOW ENERGY P-WAVE RESONANCES IN MESON–MESON SCATTERING

David John Land (Ph.D. Thesis) 1966 123 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-2258

The bootstrap mechanism, within the S-matrix approach to the strongly-interacting particles, is used in studies of two low-energy p-wave resonances. We perform a self-consistent calculation for the ρ meson in π–π– scattering. A self-consistent p-wave resonance is found at 308 MeV. It is concluded that the ρ meson is not capable of producing itself self-consistently and that some other mechanism is responsible for the 750 MeV p-wave resonance observed in the π–π– system. In a second calculation, the reciprocal bootstrap idea is applied to the ρ and B mesons in π–ω scattering. The ρ appears as a 1^- bound state in the π–ω system. Our results show that the ρ can be produced self-consistently at its experimental mass. On the other hand, a completely self-consistent B meson can be obtained in reasonable agreement with experiment only if the distant singularities associated with ρ exchange are neglected. Otherwise, ρ exchange is effectively repulsive in the 2^- amplitude. Dissert. Abstr.

N68-26568# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).

CROSSING RELATIONS FOR HELICITY AMPLITUDES IN PROCESSES WITH N FINAL PARTICLES AND THEIR IMPLICATIONS FOR THE MULTI-REGGE MODEL

A. Capella Jan. 1968 31 p refs
(LPTHE-TH-235)

The crossing relations for helicity amplitudes are generalized to processes with n particles in the final state; these relations are obtained under the assumption that the spinor amplitudes are analytic in a domain big enough to allow crossing. The crossing relations turn out to be very similar to those for two-body processes. The consequences of the crossing relations for the multi-Regge model are analyzed, mainly in connection with the factorization principle. Applications are made to the study of decay angular distributions of resonances produced in such processes. Author (NSA)

N68-26591# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

MEASUREMENT AND ANALYSIS OF HIGH-ENERGY RADIATION THROUGH ACTIVATION DETECTORS. APPLICATION IN DOSIMETRY [SUR LA MESURE ET L'ANALYSE DES RAYONNEMENTS DE HAUTE ENERGIE PAR DETECTEURS A ACTIVATION. APPLICATION A LA DOSIMETRIE]

Laodamas Sklavenitis (Ph.D. Thesis—Toulouse Univ., 18 Oct. 1967) Jan. 1968 141 p refs In FRENCH
(CEA-R-3376)

Measurement and analysis of radiation fluences within objects of small volume submitted to a high energy proton beam are studied. A detailed study of the radiation nature and energy spectra as well as of the various dosimetry methods is presented. In order to select a group of detectors, high energy nuclear reactions were systematically studied and for some of them cross sections were measured or calculated: for example the cross section of the reaction $^{11}B(p,n)^{11}C$ between 150 and 3,000 MeV and of the reaction $^{34}S(p,2pn)^{32}P$ between 50 and 3,000 MeV. The second part is relative to the application of the aforementioned analysis to radiation within a tissue equivalent phantom irradiated by 3-GeV protons. This analysis is sufficiently detailed to allow the reconstitution of the absorbed doses, the dose equivalent and, contingent on a better knowledge of the dose due to heavy particles, the quality factors. It allows also to follow the evolution of the various dosimetric data as a function of the depth inside the phantom and to verify calculations already done by other researchers. The comparison of the measured doses and the corresponding detector activities shows that some detectors could give directly the absorbed dose, or even the dose equivalent, by a simple activity measurement. Author (NSA)

N68-26612# Georgia Inst. of Tech., Atlanta. School of Chemistry.

MEASUREMENTS BY IMPROVED METHODS OF ACTIVATION CROSS SECTIONS FOR 14.4 MEV NEUTRON REACTIONS

R. W. Fink 26 Feb. 1968 21 p refs Presented at Conf. on Small Accelerators, Oak Ridge, Tenn., 8–10 Apr. 1968
(Contract AT(40-1)-3346)
(ORO-3346-18; CONF-680411-1) CFSTI: HC $3.00/MF $0.65

The development of improved techniques for precision measurement of activation cross sections is reported. These new techniques take advantage of the high resolution of Ge(Li) detectors. For short-lived products, a fast pneumatic transport system (≈800 msec) is used, together with a digital tape recorder to store rapid, successive 400-channel spectra from rapidly decaying samples observed with a 16-cc Ge(Li) spectrometer. Precision cross sections for reactions of isotopes of Kr, Si, Zn, Br, Rb, Se, Fe, Ge, Cd, Pd, Hg, Tl, and Au are tabulated. These values are being fitted into a revised system of cross section systematics, from which all questionable early data are excluded. Current work on Xe isotopes and other elements is discussed. Improvements in the operation of a 200 kV accelerator are reported, and its proposed use as a source of bremsstrahlung-free characteristic x rays for atomic physics investigations and for high-resolution (medical) x-ray photography is pointed out. Author (NSA)

N68-26616# Columbia Univ., New York.
VECTOR MESONS AND HADRONIC CURRENTS
G. C. Wick Jan. 1968 26 p refs Presented at the Intern. School of Phys. Enrico Fermi, Varenna, Italy, 1967
(Contract AT(30-1)-1932)
(NYO-1932(2)-130) CFSTI: HC $3.00/MF $0.65

The connection between spin-1 resonances in two- and three-pion systems and the electromagnetic interactions of hadrons is considered. A background is given, but all results are not reviewed. A simplified model in which protons, represented by a Dirac field interact with the electromagnetic field in the conventional way is discussed. In addition there is a neutral vector field representing the meson (ρ^0). This field is coupled to the current four-vector of the proton field in the same way as the electromagnetic field, only with a different coupling constant. NSA

N68-26678# Max-Planck-Institut Fuer Kernphysik, Heidelberg (West Germany).
RESEARCH ON THE ATTACHMENT OF NEUTRAL AND ELECTRICALLY CHARGED DECAY PRODUCTS OF RADIOACTIVE INERT GASES TO AEROSOLS Progress Report, 1 Jan.–3 Dec. 1966
Sep. 1967 80 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-79)

Large-scale measurements of attachment properties of neutral and electrically charged decay products to aerosols were carried out. The object of these investigations was to determine the size distribution of an aerosol (the naturally occurring aerosol was used) in the submicroscopic range by means of a new-developed method and to measure the coefficient for attachment and the mean time for neutral decay product capture to a given aerosol mixture. Author (NSA)

N68-26697# Duke Univ., Durham, N. C. Nuclear Structure Lab.
NUCLEAR PHYSICS Progress Report
31 Dec. 1967 55 p refs
(Contract AT(40-1)-1067)
(ORO-1067-2) CFSTI: HC $3.00/MF $0.65

The cross sections of several neutron-induced and charged particle-induced reactions were investigated, and information on the excited states of several nuclei was obtained. The neutron total cross sections of a number of isotopes and the average neutron total cross sections of several elements and compounds were measured. Optical-model analyses of reaction cross sections were performed, and the J dependence of angular distributions for (He-3,α) reactions on light nuclei was studied using the diffraction model. The development of a windowless gas target chamber and the status of a Van De Graaff tandem accelerator using a cyclotron injector are also reported. NSA

N68-26720# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.
INTEGRAL REPRESENTATIONS IN THE EUCLIDEAN QUANTUM FIELD THEORY AND THEIR CONSEQUENCES IN RELATIVISTIC CASE
V. P. Gachok 1967 36 p refs
(ITF-67-50)

Integral representations of the vacuum expectation values of the products of field operators with account for local commutativity and positive definiteness are considered. The existence of a positive measure generating vacuum expectations is proved with the help of commutative algebra of operators of the field type constructed by the characteristic function of the Euclidean quantum field theory. The integral representations are given in the Euclidean quantum theory, after which the representations are obtained by analytical continuation in the relativistic case. The integral expansions of the Wightman functional in elementary functions are investigated. Author (NSA)

N68-26752# Chicago Univ., Ill.
SOFT PION PROCESSES
Yoichiro Nambu Jan. 1968 21 p Presented at the Meeting of the Am. Phys. Soc., Chicago, Jan. 1968
(Contract AT(11-1)-264)
(COO-264-421; CONF-680102-2; EFI-68-11) CFSTI: HC $3.00/MF $0.65

A review is given of soft pion processes, that is, processes in which low-energy (compared to other particles in the reaction) pions are emitted, absorbed, or scattered. Low-energy theorems for pions, the soft-pion formula, and nonlinear chiral Lagrangian models and gauge fields are discussed. NSA

N68-26755# Stockholm Univ. (Sweden).
TRANSITION RATES IN MEDIUM AND HEAVY NUCLEI. EXPERIMENTAL STUDIES WITH THEORETICAL INTERPRETATIONS
Sven G. Malmskog (Ph.D. Thesis) 1967 360 p refs
(NP-17386)

A collection of 24 papers that have appeared either in Nuclear Physics or in Arkiv for Fysik is presented. The papers deal with the experimental determination and theoretical analysis of single-particle transition rates in deformed nuclei and in nuclei outside the deformed regions. The development of the γ coincidence system, the rabbit system, and the long-lens electron-electron coincidence spectrometer that were used in the measurements is discussed in some of the papers. NSA

N68-26757# Akademiya Nauk URSR, Kharkov. Fiziko-Tekhnicheskii Institut.
FISSION OF NUCLEI BY HIGH ENERGY PHOTONS AND ELECTRONS [DELENIE YADER FOTONAMI I ELEKTRONAMI VYSOKIKH ENERGII]
Yu. N. Ranyuk (M.S. Thesis) 1967 63 p refs In RUSSIAN
(NP-17325)

The photofission reaction is a partial case of the interaction of photons with nuclei, based primarily on a wavelength-dependent absorption mechanism. The problem was approached by studying the fission of Be, Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, Tl, Au, Pt, Os, Re, Ta, Hf, and Sm nuclei by >1600-MeV photons; the fission thresholds of these nuclei lie above the giant resonance energy. The wide range of masses used allowed to clarify the photofission cross section as a function of the mass of the target nucleus. The isotopic lead targets were used to examine the effect of the nuclear shell structure on the photofission at high photon energies. The fission of uranium by 35- to 260-MeV electrons was also investigated because of the high photofission cross section of this nucleus. The angular distribution of the photofission products of Bi, Pb, Au and Pt, measured at photon energies from 100 to 260 MeV were found to be isotropic within 5%. The lack of marked anisotropy may be due to the fact that the fissioning nucleus is formed by the emission of a large number of nucleons as the result of nuclear cascades and evaporation. The photofissibn studies were carried out on the 360-MeV and 2-GeV linear electron accelerators of the Kharkov Physico-Technical Institute; for the electron-induced fission studies, the 360-MeV electron accelerator was used. NSA

N68-26765# Naval Radiological Defense Lab., San Francisco, Calif.
THERMAL-NEUTRON FISSION OF U^{235}; IDENTIFICATION AND FRACTIONAL CHAIN YIELD OF GA^{77}
Leon Wish 11 Feb. 1968 24 p refs
(Contract AT(49-2)-1167)
(USNRDL-TR-68-35; AD-668329)

The study of nuclear charge dispersion in the light-fission-product region from thermal-neutron irradiation of 235U was begun with measurements on mass chain 77. An ion exchange procedure was developed which rapidly separated Ga from its daughter products, Ge and As. Ga separations were made at

various times after fission and the Ge daughter activities were isolated and measured. From these activities 77Ga and 78Ga were indirectly identified as fission products. The half-life of 77Ga was determined to be 17.1 plus or minus 1.5 sec and that of 78Ga was estimated to be about 4 sec. The branching ratio of 77Ga for formation of 77mGe and 77gGe was obtained from measurements of the 39-hr 77As activity at the time when the 54-sec 77mGe and the 11.3-hr 77gGe had each mostly decayed. Values obtained for decay to 77mGe and 77gGe are 0.88 plus or minus 0.02 and 0.12 plus or minus 0.02, respectively. The fractional cumulative yield of 77Ga was determined as 57.3 plus or minus 1.4 percent. Author (TAB)

N68-26776# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

SIX-PRONG INTERACTIONS OF 16 GEV/C π^- WITH PROTONS

T. Hofmokl, L. Michejda, S. Otwinowski, H. Piotrowska, R. Sosnowski et al 1967 13 p refs

(INR-837/VI/PH)

About 4000 six-prong interactions of 16-GeV/c π^- with protons recorded in the 2m HBC were measured. Cross sections for fitted channels are given. In the reaction $\pi^- p \rightarrow p\, 2\pi^+ 3\pi^-$ copious production of $N^{2++}(1236)$ (≈35%) and ρ^0 (≈60%) is observed. In the reaction $\pi^- p \rightarrow p\, 2\pi^+ 3\pi^- \pi^0$ the $N^{2++}(1236)$ production is weaker, but there is a good evidence for ρ^0 (≈30%) and ω^0 (≈15%) production. Single particle distributions are discussed as well as the Goldhaber effect. Author (NSA)

N68-26792# Atomic Energy Establishment, Winfrith (England). Control and Instrumentation Div.

DRIFT CORRECTION OF BINARY CROSS-CORRELATION MEASUREMENTS

J. D. Cummins 1968 15 p refs

(AEEW-R-583) CFSTI: HC $3.00/MF $0.65

Techniques are described for the elimination of quadratic and higher order approximations to drift of dependent variables in dynamic measurements on power plants, such as nuclear reactors. The techniques were developed for the Winfrith on-line binary cross-correlation, which uses pseudo-random chain codes. The techniques require that a length of recording of the output variables of the plant equivalent to two periods of the chain code be available to perform the off-line calculation, and only one selected term in the polynomial approximation to the drift is eliminated. For example, a correction for any linear drift may be made leaving a residual due to quadratic and higher powers. Drift correction of binary cross-correlation measurements is shown to be feasible at the expense of a longer recording time. The errors introduced to cross-correlation measurements for linear, quadratic, cubic, quartic, and quintic drift laws are presented in graphical form. NSA

N68-26795# Paris Univ., Orsay (France). Linear Accelerator Lab.

STUDY OF FOCUSING A BEAM OF ULTRARELATIVISTIC ELECTRONS IN A LINEAR ACCELERATOR. APPLICATION TO THE ORSAY LINEAR ACCELERATOR [ETUDE DE LA FOCALISATION D'UN FAISCEAU D'ELECTRONS ULTRA-RELATIVISTES DANS UN ACCELERATEUR LINEAIRE. APPLICATION A L'ACCELERATEUR LINEAIRE D'ORSAY]

L. M. Ah-Hot (Ph.D. Thesis) 1967 83 p refs In FRENCH

(LAL-1178)

Focusing a beam of ultrarelativistic electrons in a linear accelerator was studied. This study made it possible to analyze a complex of problems connected with the natural divergence of the electron beam. These problems are resolved by the adaptation concept in the phase space of the admittance and the maximum possible emittance. This leads to the study of adequate accelerating lengths and focusing systems to minimize particle losses from the first optical element. These results were applied to the Orsay Linear Accelerator. The actual evolution of the beam in the quadrupole optics is calculated, and the effects of aberrations are determined theoretically. The results obtained experimentally are compared with the theoretical predictions. NSA

N68-26796# Hawaii Univ., Honolulu. Dept. of Physics and Astronomy.

ANNUAL PROGRESS REPORT OF THE HIGH-ENERGY PHYSICS GROUP, JANUARY 1–DECEMBER 31, 1967

15 Feb. 1968 20 p refs

(Contract AT(04-3)-511)

(HEPG-23; UH-511-23) CFSTI: HC $3.00/MF $0.65

The report of the high-energy physics group at the University of Hawaii covers research for the year 1967. This research is both experimental and theoretical and includes bubble and spark chamber experiments. NSA

N68-26818# Akademiya Nauk URSR, Kiev. Institut Teoreticheskoi Fiziki.

ALGEBRA OF MESON CURRENTS IN THE MODEL OF QUASI-INDEPENDENT QUARKS [ALGEBRA MEZONNYKH TOKOV V MODELI KVAZINEZAVISIMYKH KVARKOV S VYKLYUCHENNYM VZAIMODEISTVIEM]

V. P. Shelest 1967 22 p refs In RUSSIAN; ENGLISH summary

(ITF-67-51)

The model of quasi-independent quarks with switched-off interaction is considered. In the framework of this model, relativistic-invariant meson matrix elements are constructed and a current algebra is proved to take place in any order in the quark inverse effective mass. Author (NSA)

N68-26827# Bettis Atomic Power Lab., Pittsburgh, Pa.

FISSION SPECTRUM AVERAGED CROSS SECTION MEASUREMENT FOR Be^9(N, 2N) REACTION (LWBR-LSBR DEVELOPMENT PROGRAM)

L. Green Jan. 1968 18 p refs

(Contract AT(11-1)-GEN-14)

(WAPD-TM-667) CFSTI: HC $3.00/MF $0.65

The ^{252}Cf spontaneous fission neutron spectrum averaged ^9Be (n,2n) cross section was measured to an accuracy of 4% using a manganese sulphate bath technique. The value obtained, 144 ± 6 mb, agrees with the prediction of 150 mb based on the latest available differential cross section measurements. In particular, in the region 2 to 4 MeV where uncertainties in the data are greatest, the cross section is adequately described. Author (NSA)

N68-26829# California Univ., Livermore. Lawrence Radiation Lab.

METHOD OF PREPARING PLUTONIUM SCREENS FOR SOFT X-RAY SPECTROGRAPHY

L. de Bersuder Mar. 1968 28 p refs Transl. into ENGLISH of Comm. a l'Energie Atomique Rept. CEA-2338, 1963

(UCRL-TRANS-10232; CEA-2338) CFSTI: HC $3.00/MF $0.65

Thin layers of pure plutonium (thickness 100 to 10,000 Å) were prepared by thermal vacuum evaporation. The plutonium was protected against oxidation by vacuum deposition of aluminum layers under and above the plutonium layer. The purity of the layers was checked by electron and X-ray diffraction which showed that very thin films of plutonium condense in β form instead of α. Author (NSA)

N68-26847# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.

PROCEEDINGS OF THE 7 CRACOW SCHOOL OF THEORETICAL PHYSICS, VOLUME 1

Jun. 1967 222 p refs

(INP-555/PH)

In the series of lectures presented, attention was centered on the mathematical aspects of theoretical and nuclear physics.

Included among the topics were (1) algebraic formulations of dynamical theories of the composite systems with mass splitting, (2) dynamical theory of quarks, (3) phase function method of potential scattering theory, (4) kinematical singularities of the scattering amplitudes, (5) algebraic approach to quantum mechanics and local quantum field theory, (6) symmetry and the hydrogen atom, and (7) decay laws for unstable particles. B.S.D.

N68-26862 Joint Publications Research Service, Washington, D. C.
RADIATION EFFECTS IN EXPERIMENTS WITH OPPOSED ELECTRON-POSITRON BEAMS
S. M. Sukhanov 7 Jun. 1968 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 178, no. 4, 1968 p 822–824
(JPRS-45594) CFSTI: $3.00

Photon emission during electron-positron collisions was investigated, and formulas were derived for the electron-positron scattering cross section involving the emission of a photon of arbitrary energy in narrow cones along the direction of the particle motion. The emission cross section of soft quanta for arbitrary electron scattering angles was derived, along with formulas for correcting the electron-positron scattering cross section to a logarithmic accuracy which make an allowance for e^2 order radiation corrections. M.W.R.

N68-26872# Sandia Corp., Albuquerque, N. Mex.
TECHNIQUE FOR UNFOLDING NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS
C. R. Greer, J. A. Halbleib, and J. V. Walker Dec. 1967 99 p refs
(Contract AT(29-1)-789)
(SC-RR-67-746) CFSTI: HC $3.00/MF $0.65

A technique is presented for solving the Fredholm integral equations describing neutron activation spectroscopy measurements. Through the representation of the spectrum and cross sections as piecewise linear functions of energy, the set of activation integral equations are reduced to a matrix equation. By introducing a constraint involving a best trial spectrum, it is shown that certain additional physical information usually available to an experimenter can be utilized. Based upon this constraint a unique solution to the matrix equation can be obtained. A computer code incorporating this technique is described. The user has the option of obtaining the closed form exact solution and/or an approximate solution arbitrarily close to the exact solution through an iterative procedure. A rigorous theoretical description of the method is also presented. Author (NSA)

N68-26912 Michigan Univ., Ann Arbor.
THE ^{208}Pb(d,p) ^{209}Pb REACTION WITH 15 TO 25 MEV DEUTERONS
Andrew Stephen Poltorak (Ph.D. Thesis) 1966 80 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8330

The purpose of this study was to measure differential cross sections from the ^{208}Pb(d,p) ^{209}Pb reaction for the seven low lying energy levels in ^{209}Pb and to determine the best set of parameters and conditions for the Distorted Wave Approximation (DWA) analysis of these cross sections. Deuterons with energies of 14.8, 20.1 and 24.8 MeV were used for the measurements. The protons were analyzed in momentum with the magnetic reaction products analysis system at the facility and detected either with nuclear emulsions or a sonic spark chamber. The measurements and analysis made in this study have located and identified the seven expected levels in ^{209}Pb. Using the best conditions as standard, the other two conditions gave results with lower spectroscopic factors, but essentially the same shape of the angular distributions, for the same lower integration radius. The effect of varying the lower integration radius was random in both the shape and magnitude of the predicted cross sections. Since the results of the conditions used were so varied, no parameter changes were tried. In conclusion, only partial success has been obtained in the calibration of the DWA in the mass and energy region studied; while l-values can be obtained reliably, spectroscopic factors can be extracted only to about ±40%. Dissert. Abstr.

N68-26919 Pennsylvania Univ., Philadelphia.
WIDE ANGLE ELASTIC SCATTERING OF PIONS FROM HYDROGEN AT 4 TO 10 GeV/C
Richard Charles Lanza (Ph.D. Thesis) 1966 191 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-7856

The differential cross-section for elastic scattering of π^+ and π^- mesons from protons has been measured using a system of scintillation counters and spark chambers for incident pion momenta of 4, 6, 8, and 10 GeV/c. The cross-section was measured for center of mass pion scattering angles of approximately 140 to 165 degrees, corresponding to values of u (the square of the four-momentum transfer from incident pion to emergent proton) of approximately −1.5 to −0.1 $(GeV/c)^2$. The following conclusions were reached: (1) The properties of the peaks, and the differences for π^+ and π^-, appear to be most readily explained by a baryon-exchange model rather than an optical model. (2) The differences in the shapes of the peaks, and the energy dependence of the peaks, are not consistent with the predictions of a perturbation theory (pole term) calculation of the baryon exchange process. (3) All features of the data, including the dip effect, are consistent with an exchange model in which the exchanged baryon exhibits "Regge-like" behavior. Dissert. Abstr.

N68-26931# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
GEOMETRICAL CHECK OF THE ISOTOPIC INVARIANCE [GEOMETRICHESKAYA PROVERKA IZOTOPICHESKOI INVARIANTNOSTI ELEMENTARNYKH CHASTITS]
V. G. Grishin and M. I. Podgoretskii 1968 6 p refs In RUSSIAN Submitted for publication
(JINR-P2-3691)

Some possible experiments are considered for checking the isotopic invariance of strong interactions of elementary particles. Author (NSA)

N68-26941 Minnesota Univ., Duluth.
RARE DECAY MODES OF THE η-MESON
Bing-Lin Young (Ph.D. Thesis) 1966 173 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-7809

The rare decay modes of the η-meson to be considered are the Dalitz pair decay modes, $\eta \to l^+l^-\gamma$, and the direct modes $\eta \to l^+l^-$, with l representing an electron or muon. A model is used to evaluate the form factor. In the model, the low energy and the high energy behaviors are separately considered. The low energy function is assumed to dominate by the vector meson and is evaluated by means of a once subtracted dispersion relation. The high energy function is evaluated by a perturbation calculation at the $\eta V'V'$ coupling while V' is either a photon or a vertex meson. Members of the baryon octet are used as the intermediate states. A numerical calculation for the branching ratios (with $\eta \to 2\gamma$) of the Dalitz pair decays and the direct decays, and the lepton pair distribution on the Dalitz pair decays are carried out. The general relation between direct branching ratios and the high energy behavior of the form factor have been observed. Experimental problems of testing the models as well as the prediction of the models are also observed. Dissert. Abstr.

N68-26948 Arkansas Univ., Fayetteville.
RADIO FREQUENCY TIME-RESOLVED SPECTROSCOPY: A MEASUREMENT OF THE LAMB SHIFT AT THE n=4 LEVEL IN IONIZED HELIUM

Lynn La Mar Hattfield (Ph.D. Thesis) 1967 99 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8724

A novel method that should be generally useful in r.f. spectroscopy between two states having different lifetimes has been developed and used to measure the Lamb shift in the n=4 level of He^+ ($4^2S_{1/2} - 4^2P_{1/2}$ energy difference). The sampling technique consists of exciting atoms by a gated beam of electrons and observing the time-rate of decay of radiation emitted by the excited atoms after the electron beam is turned off. The Lamb shift is measured by applying the sampling technique to the n=4 level in He^+. In this experiment, a gated beam of 300 eV electrons is used to excite the n=4 level of He^+ by simultaneous ionization and excitation. The λ4686 Å (n=4→3) radiation is monitored with the sampling oscilloscope set to sample 20 nsec after beam cut off so that only 4s→3p decay is present. The standard technique of inducing $s_{1/2}$–$p_{1/2}$ transitions is used. The loss in 4s→3p radiation is then a measure of the net $4^2S_{1/2} - 4^2P_{1/2}$ stimulation. The lifetime of the 4s state in He^+, determined from the averaged results of thirteen independent measurements, is $(1.3_6 \pm 0.2_0) \times 10^{-8}$ sec. This agrees with the theoretical value of 1.4154×10^{-8} sec. The Lamb shift is determined by finding the magnetic field strength corresponding to the center of the absorption curve. The averaged result of eleven independent measurements is (1766.0±7.53) MHz. This agrees with the best available theoretical value, (1768.2±0.6) MHz. Dissert. Abstr.

N68-26952 Cornell Univ., Ithaca, N. Y.
POLARIZATION OF Λ HYPERONS IN THE REACTION $\Gamma + p \rightarrow K^+ + \Lambda$
Helen Thom Edwards (Ph.D. Thesis) 1966 178 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-1462

The polarization of Λ hyperons, perpendicular to the production plane, has been measured for the reaction $\gamma + p \rightarrow K+ + \Lambda$ using the Cornell 1.4 GeV electron synchrotron. Measurements at approximately 90 degrees in the center-of-mass system have been made for five photon energies ranging from 1000 to 1120 MeV in the laboratory. The experimental arrangement incorporated a magnetic spectrometer for the detection of the K+ mesons, and a system of two identical counter telescopes positioned above and below the production plane for the detection of the protons from the asymmetric decay of the associated Λ hyperons. The kinematics of the reaction was determined by the aperture of the K meson spectrometer. The polarization of the Λ was related to the ratio of the number of decay protons detected in the two telescopes. A detailed analysis of all low energy K + Λ photoproduction data is given as an appendix. Dissert. Abstr.

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N68-25760*# Stanford Univ., Calif. Inst. for Plasma Research.
CYCLOTRON HARMONIC WAVE PHENOMENA IN PLASMAS
F. W. Crawford Jul. 1967 35 p refs Presented at the 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna, Aug. 1967
(Grant NGR-05-020-077; Contract AT(04-3)-326)
(NASA-CR-89184; SUIPR-189) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Since about 1965, studies of a wide variety of plasma phenomena associated with cyclotron harmonic frequencies, e.g. absorption, noise emission, ringing, scattering, and admittance peaks, have suggested strongly that they are dependent on the propagation characteristics of the warm magnetoplasma longitudinal waves referred to as cyclotron harmonic waves (CHW). This paper reviews the correspondence between the theoretical and experimental activities in the field. The most significant result of the work is that, since the CHW propagation is predicted only by microscopic theory based on the Boltzmann equation, the close agreement between theory and experiment adds considerably to the confidence in the mathematical procedures governing the description of warm magnetoplasma wave and instability properties. The results complement those on Landau damping obtained under conditions where magnetic field effects are unimportant. These are dealt with in an accompanying review. Author

N68-25766*# Techtran Corp., Glen Burnie, Md.
DEPENDENCE OF THE STARTING CHARACTERISTICS OF AN ELECTRONIC CYCLOTRON GENERATOR ON THE DISTRIBUTION OF THE HIGH FREQUENCY FIELD IN THE DIRECTION OF PARTICLE DRIFT [ZAVISIMOST' PUSKOVYKH KHARAKTERISTIK ELEKTRONNOGO TSIKLOTRONNOGO GENERATORA OT ZAKONA RASPREDELENIYA SVCH POLYA V NAPRAVLENIY DREYFA CHASTITS]
V. A. Zhurakovskiy and S. V. Koshevaya Washington NASA May 1968 8 p refs Transl. into ENGLISH from Izv. Vuzov. SSSR, Ser. Radioelektron. (USSR), v. 10, no. 11, 1967 p 1003–1008
(Contract NASw-1695)
(NASA-TT-F-11730) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Methods from the theory of weak signals are used to solve the self-consistent problem of the interaction of a spiralized electron stream with an electromagnetic field of a resonator of considerable volume. The field disturbed the movement of the particles in the cases of homogeneous, gaussian, and sinusoidal change of signal amplitude along the tube. A comparative analysis of the starting parameters of the corresponding types of cyclotron generators is performed. It is shown that self-excitation of the system is hindered with increasing power of the heterogeneity in the distribution of amplitudes of the hf field. Author

N68-25772# Atomic Energy Commission, Washington, D. C. Technical Information Div.
REPORT OF AD HOC PANEL ON LOW-BETA TOROIDAL PLASMA RESEARCH
Marshall N. Rosenbluth, Roy Bickerton, Robert A. Dory, Edward A. Frieman, Harold P. Furth et al Mar. 1968 121 p
(TID-24228) CFSTI: HC $3.00/MF $0.65

Theoretical and experimental discussions of a general nature on low-beta toroidal confinement are included. The various specific proposals for toroidal confinement are evaluated. Conclusions and recommendations are included. NSA

N68-25775*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A TECHNIQUE FOR SIMULATING THE IONOSPHERIC PLASMA
Donald R. Burrowbridge (M.S. Thesis—Catholic Univ. of Am.) May 1968 24 p refs
(NASA-TM-X-63226; X-325-68-172) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Techniques and hardware are described by which an environment simulating the plasma of the ionosphere can be produced. This environment was developed to determine the operating characteristics of spacecraft systems and experiments in the presence of charged particles, and to determine the effectiveness of electrostatic shields against the charged particles. The plasma is produced by a low energy electron beam ionizing the residual gas or introduced gas in a vacuum chamber. The relative motion between an orbiting spacecraft and the ionized media is included by accelerating the ions through a screen into the test volume. Ion beams 40 inches in diameter have been produced to simulate the

electron and ion densities of the F-region. Tests to date have shown open cathode photomultiplier tubes particularly vulnerable to charged particles as indicated by noise and transients in the signal circuits of the tubes. Plasma energies and densities are determined by retarding potential analysers and Langmuir probes. Author

N68-25821*# Space Sciences, Inc., Waltham, Mass.
PLASMA BOUNDARY INTERACTIONS—2
S. Aisenberg, P. Hu, V. Rohatgi, and S. Ziering Washington, D. C. NASA Jun. 1968 68 p refs
(Contract NASw-1014)
(NASA-CR-1072) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A study has been made of additional factors describing plasma-boundary interactions. The theoretical analysis of the sheath has been extended to include a transverse plasma flow outside the sheath region. The sheath model has been made more general, and also reveals the importance of the accommodation coefficients at the boundary surface. The presence of ionization and collisions in the sheath has also been studied theoretically. The interpretation of the experimentally observed threshold in the tangential electrode drag as a function of transverse magnetic field and of arc current has suggested the possibility of a threshold in the tangential accommodation coefficient. The threshold tangential energy appears to be proportional to the sputtering threshold and can be related to the threshold for displacement of surface atoms. The relationship between plasma phase velocity and particle velocity was studied and it was shown that there is not necessarily a simple connection: The related problem of arc retrograde motion (where plasma phase and particle motion have opposite signs) was studied and a simple model was proposed. It appears that the plasma propagates in the retrograde direction because of an increased net ion generation rate due to the inhibited diffusion loss of ions and electrons in the region of higher magnetic field. The importance of direct measurement of ion and atom velocity by means such as the Doppler shift is discussed. Author

N68-25877*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
GENERAL OPERATING CHARACTERISTICS OF A BACK STREAMING DIRECT-CURRENT PLASMA GENERATOR
Roman Krawec Washington Jun. 1968 26 p refs
(NASA-TN-D-4604) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Experimental studies were performed on a plasma generator consisting of a filament and a hollow, gas-fed anode which were immersed in an axial magnetic field. The hydrogen plasma formed between the filament and anode was allowed to diffuse past the filament, through a transition section, and into a low-pressure test section. The plasma within the test section was characterized by having two groups of electrons which differed in temperature and had a peak density greater than 2×10^{12} centimeter^{-3}. The no-plasma background pressure within the test chamber was an order of magnitude less than the peak electron density. Evidence was found indicating that thermal dissociation of the hydrogen molecule occurred within the hollow anode. Author

N68-25920*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THERMODYNAMIC STUDY OF PLASMAS USING THE PRINCIPLE OF MAXIMUM ENTROPY
Norbert Stankiewicz Washington Jun. 1968 26 p refs
(NASA-TN-D-4621) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A maximum entropy (disorder) principle is used to determine the velocity distribution functions in a quiescent plasma (case 1), a current-carrying plasma (case 2), and a viscous plasma (case 3). The Saha equation (at the electron temperature) holds for case 1, and modified Saha equations hold for cases 2 and 3. The modification in case 2 is important only in situations where the directed energy of the electrons is a substantial fraction of the total energy. The results of case 3 are presented in a general form and need simplification before they can be applied to a specific situation. Author

N68-25949*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TRANSIENT SPECTRAL STUDY OF DISCHARGES IN COAXIAL PLASMA GUNS
Charles J. Michels and Henry J. Hettel Washington 1967 11 p refs
(NASA-TM-X-52340) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Time-varying spectra of argon plasma in a coaxial plasma gun are measured for two geometries. One geometry, operating self-crowbarred, exhibits a fully ionized argon plasma (relatively "clean") for the first moving discharge in the gun. Performance agrees well with earlier snowplow model theory and experiment. In contrast, the other geometry which operated in the multiple moving puff mode, exhibits a contaminated discharge with no propellant lines observed. A pyrex gas baffle is the source of contaminants. Performance does not agree with theory. Author

N68-26010 Cornell Univ., Ithaca, N. Y.
GENERAL STAGNATION-POINT FLOW IN HYDRODYNAMICS AND IN MAGNETOHYDRODYNAMICS
Robert Carl Boger (Ph.D. Thesis) 1967 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-2702

The inviscid, three-dimensional, stagnation-point flow near the front of a blunt body is investigated in full generality first in the ordinary hydrodynamic (OHD) case, and second for magnetohydrodynamics (MHD). An analytical method is developed for solution to any desired accuracy in distance from the stagnation point. The OHD analysis is begun by assuming the velocities can be expanded as power series in the coordinates x and y parallel to the body, while allowing general functional behavior in the normal coordinate, z, for the coefficient functions of all xx-terms. For the MHD analysis the non-constant electromagnetic field is taken to be of the same form previously assumed for the velocities. The MHD equations of motion become a hierarchy of nonlinear ordinary differential equations substantially more complicated than in OHD, when the assumed velocities and fields are substituted. Dissert. Abstr.

N68-26013 Cornell Univ., Ithaca, N. Y.
UNSTEADY MAGNETOHYDRODYNAMIC FLOW PAST THIN BODIES WITH INWARDLY DIFFUSING MAGNETIC FIELD
Dah-nien Fan (Ph.D. Thesis) 1967 41 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2705

A rational small-perturbation theory is proposed for treating an initial- and boundary-value problem in magnetohydrodynamic flow past thin symmetrical bodies with the thickness parameter ϵ as the perturbation parameter. An irrotational flow over the body is established initially in the total absence of electromagnetic interactions. The fluid is assumed to be incompressible, inviscid, and electrically conducting. Moreover, it is bounded by two infinite parallel planes outside which vacuum prevails. The external magnetic field is then imposed by turning on current sheets of constant intensity at the fluid-vacuum boundaries. The inwardly diffusing field penetrated the fluid, modifies the flow, and in turn is itself modified. Perturbation series valid respectively in the interior of the electrically insulating body and its exterior (the fluid and the vacuum) are written in powers of ϵ. Dissert. Abstr.

N68-26015 University of Southern Calif., Los Angeles.
ONE-DIMENSIONAL FREE EXPANSION OF A COLLISIONLESS PLASMA
Yasushi Hiroshige (Ph.D. Thesis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8041

The free expansion of a plasma is usually pictured as a combination of free-streaming ions and an oscillating electron fluid. In the present work, this conjecture is tested for the case of the one-dimensional expansion of a collisionless plasma initially in thermal equilibrium and confined between two perfectly reflecting planes. Two methods of solutions are used. The first method is an approximate method based on Vlasov's equations and the second method is a computer experiment using the sheet model. For the approximate method, an assumption is made that the velocity distribution function is constant at the one remaining boundary. For the computer experiment, the sheet model used may be compared to a series of parallel plate capacitors free to move through each other along a common axis perpendicular to the plates and under the influence of its self-consistent electric field. Dissert. Abstr.

N68-26052 Cornell Univ., Ithaca, N. Y.
GAP COUPLING TO BEAM-PLASMA SYSTEMS WITH APPLICATIONS TO AMPLIFIERS
Subrahmanyam Yegna Narayan 1967 190 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-3792

A linearized small-signal theory of gap coupling to a waveguide containing an anisotropic plasma is presented. The plasma may be cold, stationary, contain drifting components, or may have a thermal velocity distribution. The theory allows computation of the various electromagnetic fields, current modulation, and the kinetic voltage resulting from the gap excitation. The electronic loading admittance of the gap is also calculated. In view of its application to beam-plasma amplifiers, computations have been made for the model of an electron beam flowing through a gapped waveguide filled with a cold, collisionless plasma, the whole system being immersed in an axial, static, magnetic field. Both the inductive-medium regime and the traveling-wave regime are considered. Dissert. Abstr.

N68-26157# Harvard Univ., Cambridge, Mass. Engineering and Applied Physics Div.
AN INVESTIGATION OF HELIUM ARCS AT 10 ATMOSPHERES PRESSURE
C. C. Hwang Mar 1968 101 p refs
(Grant NSF GK-65)
(TR-30)

An experimental investigation of the wall-confined helium arcs at 10 atm pressure was conducted; (1) to answer whether and to what extent local thermodynamic equilibrium exists; and (2) to see if the transport properties could be obtained in case equilibrium is approached. Helium was considered as the preferred gas because of its simple atomic structure, inertness, and nonmolecular formation. The test apparatus consisted of a circular channel formed by a stack of copper disks through which a controlled amount of partially ionized helium gas flowed. The ionized gas was sustained by an electric current along the axial direction in the tube, and was confined by the cooled tube walls. Results indicated that the 10 atm arcs are not in local thermodynamic equilibrium in the region of the walls. Transport properties for a 10 atm helium arc are deduced for the temperature range 15,000° to 17,000°K and the deduced electrical and thermal conductivity agree with theoretical predictions within a factor of 2. A.L.

N68-26166 California Univ., Berkeley.
FLUTE OSCILLATIONS IN MIRROR CONFINED PLASMAS: THEORY AND EXPERIMENT
Tao-yuan Chang (Ph.D. Thesis) 1966 162 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-8538

Flute Oscillations in Bounded Plasmas and the Effect of Incoherently Precessing Ions—Flute oscillations in bounded, nonuniform plasmas are considered from the guiding center point of view. The effects of field curvature are replaced by generalized forces that are proportional to the parallel and perpendicular components of the particle energy. A perturbation analysis, covering all density regimes and including the finite gyroradius effects, is carried out in cylindrical coordinates. It is shown that the final equation can always be solved by a variational method. Investigation of Flute Oscillation With a Potassium Plasma—An experimental investigation of flute oscillations in a mirror magnetic field, using a potassium plasma, is described. The plasma, generated by surface ionization of potassium molecules on a tungsten cathode located at the center of the mirror magnetic field, has a density between 10^8 and 10^9 cm^{-3}. Dissert. Abstr.

N68-26206 IIT Research Inst., Chicago, Ill.
THEORY OF MAGNETOACOUSTIC STREAMING
John Michael Bergin (Ph.D. Thesis) 1967 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8900

It is well known that in acoustics a fluid medium undergoing small oscillatory movements may exhibit steady circulatory motions, a phenomenon which is referred to as acoustic streaming. The inference to be made on the basis of acoustic streaming is that an electrically conducting fluid in the presence of a magnetic field may exhibit phenomena of the type which occur in acoustic streaming when small disturbance waves are propagating through it. A theoretical analysis of the generation of time independent quantities due to small disturbance waves in an inviscid, electrically conducting fluid is presented; this theory is referred to as that of magnetoacoustic streaming. The analysis is based on an expansion method which is used in order to obtain the second order equations of magnetoacoustics; these equations are then studied for the separate cases of the infinitely conducting fluid and the fluid of finite electrical conductivity. Dissert. Abstr.

N68-26230 California Inst. of Tech., Pasadena.
STEADY LAMINAR COMPRESSIBLE MAGNETO-FLUID-DYNAMIC GAS FLOWS IN CHANNELS
Kenneth Gunder Harstad (Ph.D. Thesis) 1967 115 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8455

Numerical computations are carried out for the core flow of subsonic MFD generator channels with a large length-to-height ratio and fine electrode segmentation. The working fluid is taken as potassium seeded argon. Variable transport properties and radiation effects are considered. It is shown that transverse variations in fluid properties are very important in Faraday generators; a one-dimensional analysis of the flow is not adequate. Axial currents in non-equilibrium flows can be kept low if the right value of the Hall parameter can be obtained; this also depends critically on the Mach number and load parameter. Mach numbers much less than one and highload parameters are to be avoided. Attainment of very large Hall parameters and fields cannot be expected. Dissert. Abstr.

N68-26276*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A NEW MECHANISM FOR LOW-FREQUENCY OSCILLATIONS IN PARTIALLY IONIZED GASES
J. Reece Roth Washington 1967 7 p refs Presented at 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna, 27 Aug.-2 Sep. 1967
(NASA-TM-X-52333) CFSTI: HC $3.00/MF $0.65

The theory underlying a class of low frequency oscillations in partially ionized gases is developed, and the plasma continuity equations that describe these oscillations are given. These oscillations are entirely distinct from the momentum-equation instabilities that were extensively analyzed in the literature. Author

N68-26279 Stanford Univ., Calif.
TRANSPORT PROPERTIES OF A NON-EQUILIBRIUM PARTIALLY IONIZED GAS
Robert Marshall Chmieleski (Ph.D. Thesis) 1967 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-7905

A modified Chapman–Enskog approach for an ionized gas is presented. This method consists of using the Boltzmann equation and assuming a solution in the form of the usual Chapman–Enskog ansatz. The modification is contained in the treatment of the various collision terms. It is demonstrated that because of the small electron to heavy particle mass ratios, cross-collisions in the heavy particle equations can be ignored. In the electron equation, a series expansion of the heavy particle Maxwellians are used to split cross-collision terms into various orders of the expansion parameter ϵ. The method allows the electron and heavy particle temperatures to differ while requiring all species to have the same macroscopic velocity to zero order. Expressions are obtained for the transport properties of such a gas in the presence of an electric field and in the presence of both electric and magnetic fields. In both cases a complete set of self-contained hydrodynamic equations is given. Dissert. Abstr.

N68-26309# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ASYMPTOTICS OF THE WAKE OF A BODY MOVING IN RAREFIED PLASMA [ASIMPTOTIKA SLEDA TELA, DVIZHUSHCHEGOSYA V RAZREZHENNOY PLAZME]
Yu. M. Panchenko 17 Jul. 1967 23 p refs Transl. into ENGLISH from the Publ. "Issledovaniya Kosmicheskogo Prostranstva" Moscow, IZD-VO Nauka p 254–264
(FTD-MT-67-44; AD-668505)

At present there is interest in investigation of the structure of the trace formed behind a body moving in a plasma. The finding of perturbations of electron and ionic concentration in plasma leads to solution of a system of disordered kinetic equations for the distribution function of charged particles and Poissons equation for self-consistent potential. An important parameter of this problem is also the Debye radius, i.e. the distance over which the field of a point charge is chielded. Solution of the problem in the common form is very difficult since the system of equations describing perturbation is multi-dimensional and essentially nonlinear. This work gives a more detailed investigation of the structure of the trace in the distant zone. Author (TAB)

N68-26314# Forsvarets Forskningsanstalt, Stockholm (Sweden).
ROTATIONAL MOTION OF MAGNETIZED PLASMAS
E. A. Witalis Mar. 1968 9 p refs
(FOA-4-C-4341-23)

Under the simplifying assumption of constant fractional ionization, a general relation is derived for the vorticity dependence on the fields and forces present in a magnetized plasma. It is shown that time and, for a moving plasma, space variations of the magnetic field will lead to rotation if the plasma has the usual tensor conductivity, i.e., exhibits Hall effect. Author (NSA)

N68-26393# Ohio State Univ. Research Foundation, Columbus.
AN ELECTRIC ARC HELD STATIONARY BY A MAGNETIC FIELD IN A UNIFORM FLOW THEORY FOR LOW REYNOLDS NUMBER FLOW
P. F. Hodnett Wright-Patterson AFB, Ohio ARL Feb. 1968 53 p refs
(Contract F33615-67-C-1758)
(ARL-68-0025; AD-669088)

An electric arc held stationary by a magnetic field applied perpendicular to the arc axis against a gas flowing in the plane orthogonal to the arc axis is analyzed theoretically. The arc is assumed sufficiently long for a uniform column to exist where a two-dimensional analysis (in the plane of the gas flow) of the problem is adequate. The Reynolds number of the flow is taken to be small. The technique of asymptotic matching introduced by S. Kaplun is used to calculate the distribution over the entire two-dimensional plane of the quantities of interest, e.g., the temperature and velocity. Author (TAB)

N68-26398# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPTICAL PLASMA INTERFEROMETRY [OPTICHESKAYA INTERFEROMETRIYA PLAZMY]
G. G. Dolgov-Savel'yev, E. P. Kruglyakov, V. K. Malinovskiy, and V. M. Fedorov 10 Aug. 1967 15 p refs Transl. into ENGLISH of a Russian Publ.
(FTD-MT-24-83-67; AD-668290)

In addition to its other uses, optical interferometry is finding application in thermonuclear research for the measurement of plasma electron concentration. By use of this technique it is possible to determine the total number of electrons in the direction of light propagation, and when the transverse dimension is known. Another important parameter, the degree of plasma ionization, can also be determined. The article includes a description of interferometers and their light sources (optical quantum generators). Future prospects for optical interferometry are discussed briefly. Author (TAB)

N68-26400# Princeton Univ., N. J. Plasma Physics Lab.
KINETIC THEORY OF A HIGHLY NEGATIVE LANGMUIR PROBE
C. H. Su Jan. 1968 21 p refs Presented at the 8th Intern. Conf. on Phenomena in Ionized Gases, Vienna
(Contract AT(30-1)-1238; Grant NSF GP-579)
(MATT-563; CONF-670810-8) CFSTI: HC $3.00/MF $0.65

Spherical Langmuir probes in a static plasma with $R >> \lambda >> \lambda_D$ are studied, where R is the probe radius, λ the collision mean free length between charged and neutral particles, and λ_D the Debye length. The electrons are taken to have a Boltzmann distribution. Boltzmann's kinetic equation with a simple Krook collision term is used for ions. There are three physically distinct regions in plasmas around a probe. Starting far from the probe, one has: (1) Diffusion-dominated neutral region. This is obtained readily by applying the Chapman–Enskog method to the ion kinetic equation. (2) Kinetic neutral region. The diffusion process breaks down at a distance of the order of the mean free path from the probe surface. The existence of such a region depends on $\epsilon^2 \equiv (\lambda_D/R)^2 (R/\lambda)^3 << 1$. It is shown that the potential and density in this region are double-valued, with the electric field going to infinity at a certain point. For sufficiently small ϵ^2 the location of this singular point enables one to compute the saturation ion current. (3) Charge-separation sheath. A detailed analysis is given for the purpose of constructing a current-voltage characterization. Author (NSA)

N68-26408# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
OPERATION OF COAXIAL PLASMA SOURCE IN A LONGITUDINAL MAGNETIC FIELD [RABOTA KOAKSIAL'NOGO PLASMENNOGO ISTOCHNIKA V PRODOL'NOM MAGNITNOM POLE]
I. M. Zolototrubov, V. A. Kiselev, Yu. M. Novikov, and V. T. Tolok 21 Jul. 1967 15 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst. (USSR), no. 80, 1964 p 1–8
(FTD-MT-24-103-67; AD-668100)

To produce a plasmoid with a relatively small number of impurities and neutral particles, a new construction was developed, in which the coaxial plasma gun is placed in a longitudinal magnetic field, with an aim of having the rotation of the plasma in the crossed electric and magnetic fields symmetrize the discharge in azimuth and increase the degree of ionization and the magnitude of the transverse component of the particle energy. A field up to 8000 G was produced by discharging a capacitor bank. The

working gas was hydrogen. The gun-current oscillogram shows the typical plateau characterizing rotation of the plasma in the crossed fields. The rotation of the plasma was measured with external probes and the propagation of the plasma in the azimuthal direction was investigated by high-speed photography. The experiment showed that when the coaxial source is placed in a longitudinal magnetic field the plasma rotates in azimuthal direction, the discharge occurs over the entire length of the gun and is symmetrical with respect to the periphery of the electrodes. This contributes to a cleaner plasma. Spectrograms of the discharge showed that the magnetic field does decrease the intensity of the iron and chromium lines in the plasma spectrum. A shortcoming of the source is the small longitudinal plasmoid velocity (10 to the 7th power cm/sec) and insufficient ionization. Author (TAB)

N68-26481# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ACCELERATION OF ELECTRONS OF PLASMA [USKORENIYE ELEKTRONOV PLAZMY]

A. M. Stefanovskiy 12 Sep. 1967 34 p refs Transl. into ENGLISH of a Russian Publ.

(FTD-MT-67-81; AD-668120)

The acceleration of plasma electrons was studied in toroidal units where the equilibrium of the electron beam in the circular orbit is achieved with image currents arising in the metal housing around the vacuum chamber. The preliminary plasma was developed in a toroidal magnetic field by injecting electrons along the lines of force of this field and ionizing a neutral gas in the chamber. In the first series of experiments it was observed that the overwhelming majority of the plasma electrons are not accelerated after an electric field up to 150 v/cm is developed, while powerful oscillations are excited in the plasma. In the second series, the accelerating electric field was created uniformly and simultaneously along the pinch of preliminary plasma. Comparison of the plasma density with the measurement of currents arising in the plasma indicates that all the plasma electrons are initially accelerated by the electric field. It is postulated that the effects observed may be very important for obtaining large accelerated currents in plasma betatrons. Author (TAB)

N68-26482# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TRANSVERSE MOTION OF PLASMA IN A MAGNETIC FIELD [POPERECHNOYE DVIZHENIYE PLAZMY V MAGNITNOM POLE]

L. I. Yelizarov and A. V. Zharinov 8 Dec. 1967 19 p refs Transl. into ENGLISH from Yadern. Sintez (Vienna), Pt. 2, 1962 p 699–704

(FTD-MT-67-77; AD-668293)

A report is given of preliminary experiments using a plasmascope to investigate the transverse motion of plasma in a discharge with a hot cathode in a longitudinal magnetic field. It was determined that in the presence of a critical magnetic field a plasma jet is formed steadily revolving in the ionic direction. The form of the jet and the period of rotation depend on the magnetic field intensity. Comparison of oscillograms revealed that pressure and magnitude of the discharge current also essentially affect the form of the jet. With the help of the plasmascope thus far only a discharge in hydrogen was studied, mainly for the purpose of testing and adjusting the new method. Hence some discrepancies and contradictions were noted. One obvious conclusion, however, is that the observed processes of transverse motion do not have anything in common with diffusion, but are a manifestation of the instability of the configuration of the plasma. Author (TAB)

N68-26495# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE QUESTION OF THE CONSTRUCTION OF A STATIONARY MAGNETOHYDRODYNAMIC MODEL OF A CYCLONE [K VOPROSU POSTROYENIYA STATSIONARNOY MAGNITOGIDRODINAMICHESKOY MODELI TSIKLONA]

A. G. Khantadze 29 Aug. 1967 8 p refs Transl. into ENGLISH from Soobshcheniya Akad. Nauk Gruzin. SSR (Tiflis), v. 36, no. 2, 1964 p 273–278

(FTD-HT-67-75; AD-668067)

The motion of a rotating, perfectly conducting, compressible fluid in the presence of body forces and a plane magnetic field is investigated by vector multiplication. The author obtains two equations leading to the determination of the velocity and magnetic field. From these, the stationary motion of a conducting fluid is determined. The author finds the solution for the specific volume and total pressure. It is concluded that the center of rotation describes a circle with angular velocity Omega(z). TAB

N68-26509# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INSTABILITY OF DISCHARGE WITH AN INCANDESCENT CATHODE IN A MAGNETIC FIELD AT LOW PRESSURES [NEUSTOYCHIVOST' RAZRYADA S NAKALENNYM KATODOM V MAGNITNOM POLE PRI NIZKIKH DAVLENIYAKH]

M. A. Vlasov, Ye. I. Dobrokhotov, and A. V. Zharinov 10 Aug. 1967 37 p refs Transl. into ENGLISH from Yadern. Sintez (Vienna), Issue 6, 1966 p 24–34

(FTD-MT-67-75;AD-668028)

Results are given of the investigation of gas discharge with an incadescent cathode in equipotential volume in a magnetic field with an intensity of up to 2000 OE. In the investigated range of pressures from .0000021 to .001 torr there will be formed a plasma column negatively charged relative to the surrounding walls. It is established that such a discharge with an increased pressure of neutral gas becomes unstable. A steadily revolving plasma jet to the electron side pulled out from the region of the first beam will be formed. The appearance of the jet is the result of polarization of plasma in the beam of primary electrons in the presence of azimuthal heterogeneity of density and the difference in drift speeds of ions and electrons. With a further increase in pressure the stationary rotation vanishes and in the discharge there are developed intense oscillations with a continuous spectrum of frequencies. There is given an explanation of the basic regularities of behavior of the discharge. On the basis of the simplified model an expression is obtained for the frequency of rotation of the jet, which is qualitatively confirmed by the experiment. Author (TAB)

N68-26537# Stanford Univ., Calif. Plasma Gasdynamics Lab.

BOUNDARY PHENOMENA IN MHD GENERATORS Summary Report, 15 Feb. 1966–15 Feb. 1968

R. H. Eustis, E. Mitchner, and C. H. Kruger 15 Feb. 1968 20 p refs

(Contract AF 49(638)-1695)

(AFOSR-68-0959; AD-668454)

The investigations included in this research are as follows: Experiments on turbulent Hartmann flow in plasmas; Turbulence suppression in magnetohydrodynamic flows; Nonuniform electrical conduction in magnetohydrodynamic channels; Electrostatic probe theory and application in a high-temperature, collision-dominated, potassium-seeded argon plasma; Electron transport coefficients for two-temperature plasmas; Necessary conditions for the validity of the two-temperature plasma model; Experimental electrode current distributions in MHD channels; The influence of boundary layers on spectroscopic temperature measurements in MHD channels; Discharge characteristics in a seeded plasma flow. Author (TAB)

N68-26561# Kiel Univ. (West Germany). Inst. for Experimental Physics.

INVESTIGATIONS OF STRONG SHOCK WAVES. STATUS: DECEMBER 1966 [UNTERSUCHUNG VON STARKEN STOBWELLEN. (STAND: DEZEMBER 1966)]

O. E. Berge, W. Boetticher, H. Carls, H. Dammann, F. Demmig et al Aug. 1967 146 p refs In GERMAN

(BMwF-FBK-67-68) Available from ZAED, Frankfurt/Main: DM 29.20

Experimental investigations of plane (membrane shock tube, $M \leq 15$) and convergent cylindrical shock waves (Z-pinch, $M \leq 100$) are described. Using interferometric methods, an electron precursor of high electron density was found in front of the cylindrical shock fronts. In the shock tube the absolute value of the radiation cooling behind krypton shocks and the Ξ-factor of the recombination continuum of krypton were measured. Diagnostic methods (magnetic probes, uv light sources and errors in multiplier measurements) are discussed. The complete set of formulas for an explicit second-order method for solution of quasilinear totally hyperbolic systems of first order with two independent variables is given. Author (NSA)

N68-26583# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE ENERGY DISTRIBUTION OF COAXIAL SOURCE HYDROGEN PLASMA [ISSLEDOVANIYE ENERGETICHESKOGO RASPREDELENIYA VODORODNOY PLAZMY KOAKSIAL'NOGO ISTOCHINKA]

I. M. Zolototrubov, A. B. Rastrepin, and I. P. Skoblik 11 Jul. 1967 17 p refs Transl. into ENGLISH from Akad. Nauk Ukr. RSR, no. 81, 1964 p 1–10

(FTD-MT-24-107-67; AD-668057)

Energy partition in the hydrogen plasma produced in a coaxial gun is investigated in an apparatus that includes an ion energy spectrum analyzer. The plasma gun operates at 80 ka and the current period is 0.000013 sec. An active impedance reduces the third half-period to 10% of the initial amplitude. 0.8 cc of hydrogen gas is injected into the highly evacuated chamber at various intervals before the application of the voltage pulse to the gun electrodes. The ions generated in the discharge are analyzed in the ion energy detector using the magnetic field to produce selective deflection of the ions and the ion current is detected by CsI crystal optically coupled to a photomultiplier. This detector was also used to determine the time of formation of the ions in the gun by determining the time between the start of the discharge and the peak of the ion current. The energy spectrum for H1(+) ions for delay times of 0.000085 to 0.000285 sec is given. Additionally, it is shown that for short delays (85 per sec) the dominating spectrum occurs during the current maximum. For longer delays, the emergence of spectrum is delayed also. The observations are carried out for both polarities of the axial electrodes. Some difference in the spectrum is observed. Both polarities give a two-peak distribution for the shortest delay times. The major peaks occur at 10 kev. Author (TAB)

N68-26593 Cornell Univ., Ithaca, N. Y.

BALLISTIC AERODYNAMIC AND SPECTROSCOPIC INVESTIGATION OF AN RF ARGON PLASMA SOURCE INTENDED FOR A MAGNETOHYDRODYNAMIC MEDIUM

Dale Barlow Henderson (Ph.D. Thesis) 1967 68 p

Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-6421

Desiring a facility for magnetohydrodynamic (mhd) experiments, an rf argon plasma generator was built in combination with a ballistic range. Spheres are photographed in free flight (at approximately 2 km/sec) through the magnetized plasma with an image converter camera. From analysis of these photographs, the state of the neutral gas is deduced; from analysis of the spectra, the state of the electron gas is deduced. The resulting plasma properties, which were not known in advance, are not sufficient for interesting mhd experiments as is shown by an examination of the appropriate theories. A model for the structure of this type of plasma is constructed from these data using a kinetic theory approach. This model features a neutral gas temperature which is uniform over most of the plasmoid and an electron temperature which is elevated by some 900°K. in the outer skin depth. Dissert. Abstr.

N68-26606# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT THE MOTION OF PLASMOIDS IN FIELD-FREE SPACE [O DVIZHENII PLAZMENNYKH SGUSTKOV V SVOBODNOM OT POLEY PROSTRANSTVE]

Yu. S. Azovskiy, I. T. Guzhovskiy, Yu. P. Mazalov, and V. M. Pistryak 21 Jul. 1967 20 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst. (USSR), no. 49, 1964 p 1–13

(FTD-MT-24-108-67; AD-668060)

The speed of current sheets of a given density was determined by observing the main part of a plasmoid which moves in field-free space. After the ejection of a plasmoid from the source, it initially moved into a glass tube of 9 cm diameter, then into an organic glass tube of 18 cm diameter. Hydrogen was used in the experiment. In the experimental conditions, the first dense plasmoid ejected was studied. It occured during the third half-period of the discharge. Sheets of different densities move with different speeds; those of lower density are faster. With the increase of retardation (neutral gas injection into the source) the speeds of both sheets decrease. The greatest delay occurs in the small diameter glass tube. This results in a decrease of the curvature of the plasmoid front. The motion of sheets was measured by the microwave reflection doppler effect. The use of the speed of sound in plasma to characterize plasmoid thermal expansion is discussed. Author (TAB)

N68-26669# Air Force Cambridge Research Labs., Bedford, Mass. Space Physics Lab.

PLASMA CONTAINMENT IN A MINIMUM-B GEOMETRY

Charles C. Gallagher, Lewis S. Combes, and Morton A. Levine Mar. 1968 34 p refs *Its* Phys. Sci. Res. Papers, No. 353

(AFCRL-68-0140; AD-669063)

The advantages of a toroidal plasma containment device are illustrated. Low loss rates are predicted. A toroidal magnetic field is crossed with a multi-cusp magnetic field in configurations predicted by electrolytic tank analog experiments. Three such configurations are described. The first, a relatively simple device with slowly varying fields, showed the inability of the toroidal field to penetrate a plasma and strong cusp field. The second toroid, with moderately fast fields and application of rotational transform principles, produced plasma-field separation, as evidenced by a hot, relatively dense plasma contained in a central region of reduced cusp field strength. The third toroid, featuring the fastest rising fields, produced similar though more pronounced results, including a three fold compression of a plasma heated to over 15 eV, with containment times on the order of 20 microsec. Author (TAB)

N68-26671# Yeshiva Univ., New York. Belfer Graduate School of Science.

RESEARCH DIRECTED TOWARD UNDERSTANDING BEHAVIOR AND DETECTION OF PLASMAS IN MAGNETIC FIELD Final Report, 1 Jan. 1963–31 Oct. 1967

David Finkelstein Bedford, Mass. AFCRL 1 Apr. 1968 17 p refs

(Contract AF 19(628)-2399)

(AFCRL-68-0210; AD-669080)

The goal of the experimental program was the boundary region between the physics of gaseous discharges and the physics of particle accelerators. A study was made of discharges with currents large enough for collective magnetic field effects to be prominent (> or approx. 100,000 A) and voltages large enough for

relativistic effects and nuclear processes to be appreciable (> or approx. 1,000,000 V). The important pure numbers for this regime are the Dudker number A = el/m(c cubed) for the current and the relativity factory gamma = 1+ (eV/m(c squared)) for the voltage. In order to enter this region with the resources available, a certain amount of experimental development was unavoidable. The principle problems evidently cluster about producing the discharge and measuring its properties. The discharge apparatus consisted of a 100KV, 100KJ bank of standard capacitors, a dielectric switch, a 10-1 step-up transformer, delivering 1 MV output, a 1 MV water-capacitor, and an overvolted water-gap, and the gaseous discharge load. In order to minimize interference with the discharge, optical probing was felt most advisable, and a laser phasography system was worked out. Author (TAB)

N68-26695# Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.

EXPERIMENTAL STUDY OF A TRANSPIRATION-COOLED, CONSTRICTED ARC Technical Report, Apr. 1965–Jun. 1967

G. G. Gruber, E. Pfender, and E. R. G. Eckert Wright-Patterson AFB, Ohio ARL Feb. 1968 114 p refs

(Contracts AF 33(657)-7380; F33615-67-C-1353)

(ARL-68-0023; AD-668510)

Experimental work with a transpiration-cooled arc is described. An apparatus was developed which verifies the analytical prediction that an electric arc can be confined and constricted by an entirely transpiration-cooled wall. The arc was operated in argon atmosphere with currents ranging from 35 to 160 A. A porous ceramic (ALSIMAG 447) tube was used as constrictor material. The investigations encompass basic trends of the arc, the constrictor performance, and the flow behavior with their mutual interactions. By introducing some simplifying assumptions, a number of formulae, containing observable quantities were derived which are useful for the representation of experimental results and which facilitate their comparison with analytical studies. Three different types of arc characteristics are plotted and used for a description of the transpiration-cooled arc. Results of spectrometric temperature measurements in the arc jet using the 5 mm ID constrictor tube are also included. Details of an improved transpiration-cooled arc arrangement based on previous experience, are described and some preliminary results obtained with this apparatus are reported. Author (TAB)

N68-26732# Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics.

INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES Quarterly Report, 1 Jun.–31 Aug. 1967

H. Lashinsky 31 Aug. 1967 11 p

(Contract AT(40-1)-3405)

(TID-24334; QR-7) CFSTI: HC $3.00/MF $0.65

A preliminary evaluation of the electron bombardment system for the Q device was made. This system makes use of a sealed-off bombardment diode. A summary of the motivation, design considerations, and the results of preliminary tests of this diode are given. NSA

N68-26870# California Univ., Livermore. Lawrence Radiation Lab.

PLASMA CONFINEMENT WITHIN RELATIVISTIC PROTON COILS DISPOSED IN A TOROIDAL CONFIGURATION

N. C. Christofilos 5 Dec. 1967 18 p refs

(Contract W-7405-ENG-48)

(UCID-15282) CFSTI: HC $3.00/MF $0.65

In the solution of the vector potential of the E layer and the external magnetic field the slight tilt between the axis of adjacent E layers is neglected and the problem is solved in the approximation of an infinite sequence of E layers one placed adjacent to the other along the z direction. NSA

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N68-25718*# Rensselaer Polytechnic Inst., Troy, N. Y. Div. of Nuclear Engineering and Science.

OPTICAL STUDIES OF THE LITHIUM DEFECT COMPLEX IN IRRADIATED SILICON Progress Report, 15 Jun. 1967–15 Mar. 1968

John C. Corelli 15 Mar. 1968 30 p refs

(Grant NGR-33-018-090)

(NASA-CR-94916) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The lithium defect complex produced in silicon irradiated by 1.5 MeV and 45 to 50 MeV electrons was studied. The main probe used to detect the defects was the infrared spectroscopy of defect absorption bands that arise in the association of lithium atoms and vacancies and/or interstitials produced in displacement of silicon atoms by the radiation. During irradiation the temperature was maintained at $\leq 22°C$. Subsequent to irradiation the infrared spectra (1 to 50 microns) were taken with the sample kept at 300°K and at ≈80°K. Isochronal annealing experiments using 15 minute pulses were conducted at temperatures up to ≃800°K. It is indicated that the most striking results of the study are that for high lithium doping concentrations, the lithium atoms apparently combine with other defects such as the divacancy and produce either a new complex of more constituents, or the Li atoms quickly combine with single vacancies (or multiple vacancies) and thereby immobilize the vacancies and prohibit them from exhibiting further motion in the lattice. A.L.

N68-25728# Oak Ridge National Lab., Tenn. Solid State Div.

BIBLIOGRAPHY OF MAGNETIC MATERIALS AND TABULATION OF MAGNETIC TRANSITION TEMPERATURES

Mar. 1968 62 p refs

(Contract W-7405-ENG-26)

(ORNL-RMIC-7) CFSTI: HC $3.00/MF $0.65

Materials are indexed by chemical formula in two lists, ferromagnetic and antiferromagnetic materials. The upper transition temperature (the Curie or Néel temperature) is given and a reference number from the bibliography. NSA

N68-25738# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

NEUTRON SCATTERING NEAR THE FERROELECTRIC TRANSITION IN KD_2PO_4

W. J. L. Buyers, R. A. Cowley, G. L. Paul (Edinburgh Univ.), and W. Cochran (Edinburgh Univ.) Apr. 1968 13 p refs Presented at the IAEA Symp. on Neutron Inelastic Scattering, Copenhagen, 20–24 May 1968

(AECL-3084; SM-104/48) Available from Atomic Energy of Can., Ltd., Chalk River: $0.50

In the paraelectric phase of single-crystal KD_2PO_4 coherent quasi-elastic neutron scattering, the magnitude of which increases greatly as the transition temperature (−49.6°C) is approached was observed. There is no evidence for a well-defined mode with frequency falling to zero at the transition temperature. The quasi-elastic intensity is strong near reciprocal lattice points such as (3,0,1), (3,0,3) and (2,0,4) but weak near (0,0,2), (2,0,0), (2,0,2) and (4,0,2). The structure factor is consistent with the displacements of the ions at the phase transition in KDP. The scattering is therefore associated with collective atomic fluctuations in which a dipole moment is produced along the ferroelectric axis. The energy width of the scattering from the fluctuations is less than 0.2×10^{12} cps. The intensity at (3,15,0,3), neglecting any correction for resolution, exhibits Curie law behavior with $T_0 = -59.4°C$. In

contrast, the lowest frequency phonons observed do not show any strong temperature dependence. The relevance of these results to various models for the ordering of the deuterium atoms in the phase transition will be discussed. Author

N68-25864 University of Southern Calif., Los Angeles.
INFRARED ACTIVE LOCALIZED VIBRATIONAL MODES OF IMPURITIES IN GaAs
Orval George Lorimor (Ph.D. Thesis) 1967 277 p
Available from Univ. Microfilms: HC $12.60/MF $3.60 Order No. 67-8015

A localized vibrational mode of an impurity is a normal mode of the crystal which is perturbed by the impurity such that: (a) It occurs with a frequency outside of the unperturbed lattice phonon frequencies. (b) The vibrational amplitudes of the atoms of the crystal are attenuated rapidly with distance from the impurity. The particular local modes reported in this study are characterized in that they occur with a frequency higher than the maximum unperturbed lattice phonon frequency. Local mode studies yield information as to the location of an impurity in the lattice, its site symmetry, and its concentration. In samples that are heavily n- or p-type the free carriers must be electrically compensated to eliminate the infrared free carrier absorption. Li has been used for this compensation. The Li donor which compensates p-type GaAs is a simple interstitial Li. N-type material is compensated by a Li acceptor, which is presumably Li on a Ga site, LiGa. Local modes due to the Li are distinguished from those due to other impurities by Li isotope substitution. Dissert. Abstr.

N68-25870 Michigan State Univ., East Lansing.
ACOUSTIC EMISSION AND RELATED DISPLACEMENT IN LITHIUM FLUORIDE SINGLE CRYSTALS
Robert Bruce Engle (Ph.D. Thesis) 1966 137 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-7535

Acoustic emission is the result of lattice vibrations caused by mechanisms that govern deformation of crystalline materials when they are stressed. Observations were made using single crystals of lithium fluoride. Acoustic emission pulses and displacement pulses derived from rapid step displacements were observed. The largest displacements (10×10^{-6} inches) were found to occur in coincidence with large acoustic emission pulses. Smaller displacements (20×10^{-8} inches) and acoustic emission pulses were observed to occur together, though not in coincidence, throughout the tests. On the basis of these results a mechanism for the acoustic emission process is proposed. The proposed mechanism involves the interaction between piled-up groups of dislocations and the obstacles that cause the pile-up. When the driving stress on the leading dislocation is large enough to cause breakaway and acceleration of part of the group, the local strain energy is available to excite lattice vibrations that appear as acoustic emission. Dissert. Abstr.

N68-25909 Iowa State Univ. of Science and Technology, Ames.
A MOESSBAUER EFFECT STUDY OF THE MAGNETIC STRUCTURE OF SINGLE CRYSTAL ERBIUM
Richard Allen Reese (Ph.D. Thesis) 1967 86 p
(Contract W-7405-ENG-82)
(IS-T-117) Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8931

The rare earth metal erbium exists in three magnetically ordered states below its Neel temperature of 85°K. The magnetic structure of these three states was studied using the Mossbauer effect with single crystal absorbers. The ratios of the areas under the hyperfine absorption maxima are related to the angle between the direction of magnetization and the gamma ray propagation direction. By studying these area ratios it was possible tc obtain information about the magnetic structures. In the low temperature region (below 20°K), analysis of the data, on the assumption of a cone structure, yields a value of $26\pm3°$ for the semi-apex angle of the cone. In the intermediate temperature region (20–52°K), five line Mossbauer absorption spectra were obtained. In the high temperature phase, (52–80°K), a two line Mossbauer spectrum was obtained when the c-axis of the crystal was parallel to the gamma beam. For the heavy rare earths the hyperfine field is principally due to the polarization of the 4f electrons. The temperature dependence of the magnetic hyperfine field and the electric quadrupole interaction were measured between 4.2 and 80°K. Dissert. Abstr.

N68-25910 Michigan Univ., Ann Arbor.
STUDY OF LITHIUM MOBILITY IN IRRADIATED SILICON
Walter Anthony Hackler (Ph.D. Thesis) 1966 98 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8263

The objective of this study is to determine experimentally the effect of fast neutron and electron induced defects on the diffusion properties of lithium in silicon. The effect was determined by irradiating lithium diffused diodes and subsequently applying a reverse bias to the junction at a constant temperature. Experimental results show that fast neutron and 0.9 MeV electron induced vacancies provide sites for the precipitation of lithium. Moreover, the lithium vacancy precipitate behaves like a solute in equilibrium with ions and ionized vacancies. The analysis of the lithium vacancy precipitate in this fashion is analogous to the analysis of slightly soluble salts in water. The lithium diffusion coefficient for silicon exposed to fast neutrons, $N_N = 1.1$ to 2.7×10^{14} neutrons/cm^2, was found. It was also shown that the motion of lithium in silicon was not affected by slow neutron irradiation. In addition, the lithium diffusion coefficient for silicon exposed to 0.9 MeV electrons, $N_E = 5\times10^{15}$ to 3.3×10^{16} electrons/cm^3 was also derived. The range of T in the above expression is from 300° to 330°K. Relative radiation damage between neutrons and electrons was found to be in reasonable agreement with predictions based on radiation damage theory. Dissert. Abstr.

N68-25939 Cornell Univ., Ithaca, N. Y.
THE NATURE OF AC TRANSITIONS AND CRITICAL CURRENTS IN THE SUPERCONDUCTING SURFACE SHEATH
Roger William Rollins (Ph.D. Thesis) 1966 164 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-2720

The response of cylindrical Type II superconductors in the superconducting surface sheath state to an axial, low frequency (10–1000 cps), small amplitude (10^{-2} Oe $< h_o <$ 20 Oe) ac field superimposed on an axial dc field has been studied. Direct observation of the waveform representing the flux passing through the specimen shows that screening currents are developed in the sheath up to a critical value J_c when the field begins to penetrate. The screening current continues to increase until a saturation value J_s is reached. For low exciting frequencies, J_s approaches J_c for perfect surface conditions. The model is interpreted simply in terms of free energy diagrams for the superconducting sheath state based on a Ginzburg–Landau equivalent of the London fluxoid conservation concept. Measurements of the in and out of phase components of the internal field, b(t), at the fundamental frequency, $b' = \mu' h_o$ and $b'' = \mu'' h_o$ as a function of the ac field amplitude at constant dc field shows that the transition is characterized by only one parameter dependent on the dc field. Dissert. Abstr.

N68-25940 Cornell Univ., Ithaca, N. Y.
ASPECTS OF HELICON PROPAGATION IN METALS
John Raymond Merrill (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-1395

The helicon is an electromagnetic wave which can propagate in the electron gas of a solid in the presence of a large magnetic field.

Several experiments are discussed in this thesis which concern the basic properties of the helicon wave in metals and the use of the wave to measure electronic properties of interest to solid state physics. First, a brief resume of the properties of the helicon wave is given. Mode structure for helicon standing wave resonances is then discussed. Size effects in d.c. galvanomagnetic experiments as well as in helicon propagation are discussed. An attempt at the pulse propagation of helicon waves is discussed. The ability of standing wave helicon resonances to measure the anisotropy of the magnetoresistivity and the Hall coefficient is discussed in detail. Finally, the absolute calibration of uncorrected superconducting solenoid magnets is discussed. Dissert. Abstr.

N68-25950 Cornell Univ., Ithaca, N. Y.
PRESSURE DEPENDENCE OF NUCLEAR SPIN RELAXATION IN ALUMINUM POWDER
Floyd Robert Tuler (Ph.D. Thesis) 1967 92 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-9203

Nuclear spin-lattice relaxation times T_1 and spin-spin relaxation times T_2 have been measured in aluminum powder as a function of pressure to 2000 bar at a constant temperature of 450°C using nuclear magnetic resonance spin-echo techniques. Measurements were also made at constant pressure at temperatures between 430°C and 494°C. Additional line broadenings were observed which did not allow an accurate determination of the dipolar linewidth; however, the activation volume for self-diffusion in aluminum could be estimated to be greater than 12 cm^3/mole. Two mechanisms are believed to account for the additional line broadening: a temperature and pressure independent mechanism representing quadrupole coupling to strain fields of dislocations and a temperature and pressure dependent mechanism representing either local magnetic fields or quadrupole coupling to strain fields of impurities. Dissert. Abstr.

N68-25951 Cornell Univ., Ithaca, N. Y.
PARAMAGNETIC RESONANCE OF THE EXCITED $^2E(3d^3)$ LEVEL IN MgO
Lloyd Lee Chase (Ph.D. Thesis) 1967 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8758

Electron paramagnetic resonance has been performed in the excited ^2E level of the ions Cr^{3+} and V^{2+} in the cubic coordination of MgO. The resonances were detected by means of the change in circular polarized fluorescence from ^2E along the applied magnetic field as a result of microwave saturation in this state. The observed resonances have a greatly anisotropic width, which is explained in terms of the combined effects of magnetic orbital interactions and local strains, both of which split the orbital degeneracy of ^2E. The magnitude and anisotropy of the resonance width fit closely to calculations of the magnetic splitting of ^2E using parameters obtained from optical investigations of these ions by other investigators. Dissert. Abstr.

N68-25952 Rochester Univ., N. Y.
BAND STRUCTURE AND DEFORMATION POTENTIALS OF SOLID XENON
Michael Hunt Reilly (Ph.D. Thesis) 1967 193 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-8975

Relativistic valence and conduction bands, deformation potentials, and effective masses for solid xenon are found by the orthogonalized plane wave method. This is supplemented by the tight-binding method, for comparison, and for the determination of certain valence band energies and effective masses. The problem of choosing an appropriate model potential is discussed at length. A new crystal potential for insulators is developed, critically analyzed, compared with other potentials, and used in the calculations, which are carried out with high accuracy, consistent with the potential, so that results can be accurately assessed with respect to the model approximations alone. State-dependent and correlation effects for the entire band structure can be approximated, using known features of the potential for the valence band, and the resulting band structure is consistent with experiment. Dissert. Abstr.

N68-25972*# Kansas Univ., Lawrence.
INVESTIGATION OF ELECTROCALORIC EFFECTS IN FERROELECTRIC SUBSTANCES Final Report, 1 Mar. 1964–1 Jul. 1967
Gordon G. Wiseman Washington NASA Jun. 1968 78 p refs (Grant NsG-575)
(NASA-CR-1080) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The electrocaloric effect in ferroelectric and pyroelectric substances was investigated in order to obtain a better understanding of the spontaneous electrical polarization in these substances. Quantitative measurements of the electrocaloric effect are feasible over a wide range of temperature. The accuracy and validity of such measurements were established by observing the effect in a substance while it was in its paraelectric phase where the results were predictable from the Curie-Weiss law. Measurements of the electrocaloric effect in the ferroelectric region further confirm the idea that the Langevin-type model which is based on long range interactions between dipoles characterized by an inner field parameter ν is not sound. A useful characteristic of a material which is to be used as a radiation detector delivering its signal into a low-impedance detector is considered to be the pyroelectric coefficient. Under certain conditions the sensitivity of a pyroelectric radiation detector can be changed by a change in the applied field whereas in others it can be made independent of an applied field. A.L.

N68-25994 California Univ., Berkeley.
PART 1: THE MEASUREMENT OF INTERNAL CONVERSION COEFFICIENTS UTILIZING SEMICONDUCTOR DETECTORS. PART 2: DECAY SCHEME STUDIES OF THE ODD-MASS GOLD ISOTOPES
Arthur Judd Haverfield (Ph.D. Thesis) 1968 195 p
Available from Univ. Microfilms: HC $8.80/MF $3.00 Order No. 67-8574

The application of semiconductor detectors to measurements of internal conversion coefficients has been extensively discussed, with particular emphasis being placed upon a spectrometer employing both Si(Li) and Ge(Li) detectors for the simultaneous observation of conversion electrons and gamma rays. The construction, calibration and use of such a spectrometer were described. It was found that this type of spectrometer is best suited for ICC measurements of transitions following electron-capture decay. The level schemes of the odd-mass gold isotopes of mass 199, 197, 195, and 193 were examined from the decay of the respective odd-mass platinum and mercury isotopes. The measurement of numerous internal conversion coefficients permitted the assignment of spin and parity values to many of these levels. The internal conversion process was discussed along with the various experimental methods of ICC measurement. The calibration of semiconductor detectors for energy and intensity measurements was discussed. Extensive tables of standards for these calibration procedures were presented. Dissert. Abstr.

N68-25998 Michigan Univ., Ann Arbor.
A SEARCH FOR THE MAGNETIC FIELD INDUCED OPTICAL SECOND HARMONIC
Richard Arlan Phillips (Ph.D. Thesis) 1968 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8327

A search is reported for an as yet undiscovered non linear optical effect, the magnetic field induced second harmonic generation. This effect can be described by a tensor relationship between the

induced polarization and the applied fields: $P^{2\omega} = X_{ijkim}\, \epsilon_{jkm}\, B^{\omega}_{n} E^{\omega}_{l} E^{\omega}_{m}$ where P, B, and E refer to the polarization, magnetic fields, and electric fields respectively. The superscripts serve to identify the relevant frequencies, the subscripts denote cartesian components, and ϵ_{jkn} is a permutation tensor required to preserve the spatial transformation properties of the magnetic field. Theoretical and empirical considerations suggest that the expected values of the tensor coefficients are bracketed between 10^{-18} and 10^{-19} esu. Experiments designed to detect magnetic field induced second harmonic radiation were accomplished with quartz and ADP. Since no magnetic field induced signals were observed, upper limits can now be set for some of these materials. Many other materials were considered and it was decided to perform experiments with nickel sulfate, nickel selenate, and paraglass. Dissert. Abstr.

N68-26042 George Washington Univ., Washington, D. C.
INVESTIGATION OF AN APPROACH TO A THEORY OF DISLOCATED CONTINUA
Howard Stephen Wolko (Sc.D. Thesis) 1967 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-9469

An approach to the geometric description of lattice imperfections is presented. It emphasizes the relation of dislocation theory to non-Riemannian differential geometry and demonstrates the applicability of the approach to model dislocated continua as well as discrete dislocations. It is shown that the constructs known as Cartan's displacement and the discrepancy displacement provide a means for describing lattice imperfections of a geometric nature. A general, singly connected non-Riemannian manifold is used to represent a (geometrically) defect solid. Cartan's displacement is interpreted as the geometric equivalent of Burger's walk such that the Cartan closure failure corresponds to a Burger vector. All geometric quantities in the expression describing the Cartan closure failure are subsequently related to dislocation theory and shown to be representative of dislocation densities. The Riemann-Christoffel tensor is encountered in the expression describing a discrepancy displacement which is shown to be the sum of a Cartan closure vector and the change in a vector due to parallel displacement around a closed curve. Dissert. Abstr.

N68-26045 Iowa State Univ. of Science and Technology, Ames.
BARRIER CAPACITANCE OF NON-STOICHIOMETRIC BARIUM TITANATE
Theodore Vojnovich (Ph.D. Thesis) 1967 90 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8940

Barrier capacitors were prepared by the partial reoxidation of reduced barium titanates doped with gadolinium. The physical and electrical properties were dependent on the gadolinium additions and the processing variables. Gadolinium retarded the sintering rate at temperatures less than 1480°C. Additions greater than 0.004 mole Gd/mole $BaTiO_3$ aided sintering at 1480°C by inhibiting grain growth. The barrier formed by reoxidation of the titanates previously reduced in hydrogen at 925° and 1125°C was attributed to a more stoichiometric region of higher resistivity. The capacitance decreased and the resistance increased for higher reoxidation temperatures and/or longer times due to an increasing barrier thickness. The reoxidation rate was less with gadolinium additions and/or higher reduction temperatures. The barrier capacitance of the 0.010 gadolinium-doped barium titanates was examined as a depletion-type capacitance using a rectifying silver contact. The donor gradient a_c was determined from the slope of linear C^{-3} versus bias voltage plots. The donor gradient a_c determined from capacitance was compared to the donor gradient a_r determined from resistance. Dissert. Abstr.

N68-26056# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THERMAL EMF OF THE SOLID SOLUTIONS OF INDIUM PHOSPHIDE AND GALLIUM ARSENIDE [TERMOELEKTRODVIZHUSHCHAYA SILA TVERDYKH RASTVOROV FOSFIDA INDIYA I ARSENIDA GALLIYA]
N. N. Sirota and L. A. Makovetskaya 29 Aug. 1967 9 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR, v. 9, no. 7, 1965 p 435–437
(FTD-HT-66-771; AD-668114)

The dependence of the thermal EMF on the composition and temperature has been investigated in InP, GaAs, and 9 InP-GaAs alloys with a composition varying from 0.1 InP-0.9 GaAs to 0.9 InP-0.1 GaAs, and an impurity concentration within limits of 1.7×10 to the 16th power to 3.0×10 to the 19th power. The thermal EMF was measured on polycrystalline N- and p-specimens in a vacuum or a helium atmosphere in the 120–600 degrees K range; the temperature difference at the hot and cold ends of the specimens was 10–12 degrees C. The differential thermal EMF readings were practically identical during heating of cooling and increased with increasing temperature after passing through a small minimum below room temperature. At all test temperatures, the maximum value of alpha squared sigma (where sigma is the specific electric conductivity) was observed in an alloy containing 30% GaAs; with increasing temperature. The value of alpha squared sigma increased. TAB

N68-26064 Alabama Univ., University.
THE ABSORPTION SPECTRUM OF A THREE-BODY F-CENTER MODEL
David Washburne Howgate (Ph.D. Thesis) 1967 201 p
Available from Univ. Microfilms: HC $9.25/MF $3.00 Order No. 67-8481

The 0- and 1-phonon absorption spectrum of an F-center model consisting of an electron moving in the field of 2 point charges in oscillatory motion with a definite phase difference between them has been calculated, employing a formula for the spectral function which is obtained by considering the interaction of the system with the second-quantized photon field. Using as the interaction Hamiltonian that part of the electron-nuclei interaction which is linear in the nuclear displacements, the positions and magnitudes of the absorption lines were calculated through second order for a number of values of the nuclear separation, phase angle, vibrational frequency, and temperature. The matrix elements of the interaction Hamiltonian and dipole moment operator were obtained by numerical integration from the hydrogen molecular ion wavefunctions of Bates et al. Displacements of lines from their unperturbed positions and line height depend markedly on both the vibrational frequency and phase difference. Dissert Abstr.

N68-26065 Cornell Univ., Ithaca, N. Y.
ELECTRICAL AND OPTICAL PROPERTIES OF AMORPHOUS GERMANIUM
Alton Harold Clark (Ph.D. Thesis) 1967 105 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-2703

Measurements of density, optical absorption, resistivity, photoconductivity, and Hall effect have been made on amorphous Ge films ranging in thickness from one to twenty-three microns. The density was found to be $3.9 \pm .4 g/cm^3$. The absorption constant (measured at room temperature) was found to be exponential from 0.6 eV to 1.1 eV with a slope of 0.14 eV. Resistivity was determined to be 300 ohm-cm at room temperature with an activation energy of 0.15 eV. The activation energy at 30°K was about 0.02 eV. The spectral response of dc photoconductivity (measured at 4.2°K) showed a maximum at 1.5 eV, which may correspond to intrinsic transitions. The Hall measurement gave a value for carrier concentration (at room temperature) of $10^{18} cm^{-3}$ and a Hall mobility of 10^{-2} cm^2/v-sec. The sign of the Hall constant was negative. The optical measurements suggest that much of the band structure is retained in the amorphous phase.

There is an apparent contradiction, however, in that the resistivity and Hall measurements suggest transport via localized states, whereas absorption data indicate bands of non-localized states. Dissert. Abstr.

N68-26066 Oklahoma Univ., Norman.
ENERGY BAND STRUCTURE OF LITHIUM BY THE TIGHT-BINDING METHOD
Earl Edward Lafon (Ph.D. Thesis) 1967 152 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-7332

The energy band structure of lithium has been calculated by the tight-binding method. The crystal potential used in the Hamiltonian is the muffin-tin version of the Seitz potential. Block functions are constructed from the 1s, 2s, and 2p Hartree-Fock functions of the free atom and are used to set up the secular equation for the energy of a given point in the Brillouin zone. The matrix elements may be expressed as the sums over the crystal lattice points of a series of multi-center integrals with varying distances between the centers of the two atomic orbitals. For the majority of the matrix elements, to achieve convergence all the integrals for which the two centers are separated by less than six times the lattice constant must be included. The multi-center integrals are evaluated by the technique of gaussian transformation and the method for computing the matrix elements of the potential energy is described. Dissert. Abstr.

N68-26109 California Univ., Berkeley.
THE CRITICAL MAGNETIC FIELD OF SUPERCONDUCTING TIN FILMS
Francis Edward Harper (Ph.D. Thesis) 1966 99 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-8572

The magnetic behavior of vacuum evaporated clean tin films ($l_o > d$) and dirty tin films ($l_o < d$) has been studied in the superconducting state: l_o is the mean free path for colume scattering and d is the thickness of film. When a magnetic field is applied at an arbitrary angle to the surface of a sufficiently thin film ($d \leq 1000$Å), the critical field, $H_c(\theta)$, was found to satisfy certain conditions. The dependence of the critical field on volume scattering and on film geometry is contained in λ (t) (the penetration depth). As a result of the general agreement between our experiments and the theory, we conclude that the behavior of a superconducting film in a magnetic field is well described by the Ginzburg–Landau theory for temperatures near the transition temperature and for applied magnetic fields near the critical field. An important consequence of this theory is that in a perpendicular magnetic field the Abrikosov vortex state exists in a clean thin film with $H_{c1} < H_{cb}$ as well as in a dirty thin film with $H_{c1} > H_{cb}$. Dissert. Abstr.

N68-26117 California Inst. of Tech., Pasadena.
VERIFICATION OF LONG RANGE QUANTUM PHASE COHERENCE IN SUPERCONDUCTING TIN UTILIZING ELECTROMAGNETICALLY STABILIZED JOSEPHSON JUNCTIONS
Lorin Lee Vant-Hull (Ph.D. Thesis) 1967 87 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8462

De Broglie wave interferometers have been constructed, successfully utilizing extended superconducting links of tin to couple coherently the quantum phases of two Josephson junctions. The current transmitted by these devices was periodic in the enclosed flux demonstrating unambiguously coherence of the superconducting order parameter over 1.33 meters. We may define a "normal" Josephson junction as one for which the quantum mechanical coupling energy is insufficient to overcome the disruptive effects of noise. Consequently, the relative phase of the coupled superconductors is not stabilized and the "zero voltage" Josephson current fluctuates (bandwidth $\approx 2eV_{noise}/h$), averaging to zero. Two such "normal" junctions have been coupled to an electromagnetic cavity formed by the superconducting arms of a quantum interferometer (junction separation 1.33 meters). Dissert. Abstr.

N68-26160 Stanford Univ., Calif.
ELECTRON BEAM—PN JUNCTION ACTIVE DEVICES AND MEASUREMENTS
Carroll Boyd Norris, Jr. (Ph.D. Thesis) 1967 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7953

Past work with electron beam–pn junction active devices and the motivations for the present study were discussed. Measurement of the average energy pair required for creation of an electron bombardment was described. Measurement of the drift velocities of carriers in silicon at high electric fields by a time-of-flight was described. The dynamic response of electron beam–pn junction active devices was analyzed. Dissert. Abstr.

N68-26167 Cornell Univ., Ithaca, N. Y.
TEMPORAL ESTIMATION IN THE PERCEPTION OF OCCLUDED MOTION
Horace Northup Reynolds, Jr. (Ph.D. Thesis) 1967 206 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-3793

This investigation was developed in response to Michotte's studies of the "Tunnel Effect" and J. F. Brown's experiments with perceived velocity. Such studies suggest the following questions: (1) how accurately can observers estimate the amount of time required for a moving object to travel a given distance after it has passed behind an occluding obstacle; (2) what factors affect these estimates of occluded traversal duration; and (3) do these factors affect the perceived speed of the object in its visible phase of motion? These questions were examined in an experiment in which observers viewed an object moving across their field of view in front of a background surface. At the terminal end of its motion path, the object moved behind an opaque screen, on the surface of which was positioned a vertical white line. The object could be given any one of three positions. Observers were instructed to estimate the amount of time required for the object to travel from the screen's edge to the white line by pressing and releasing a telegraph key. Dissert. Abstr.

N68-26247*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRITICAL SURFACES FOR COMMERCIAL Nb_3Sn RIBBON AND Nb 25 A/O Zr WIRE
Paul R. Aron and Gary W. Ahlgren Washington 1967 19 p refs
(NASA-TM-X-52319) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The critical surface defining the boundary between the superconducting and the normal state has been determined for a sample of commercial vapor-deposited Nb_3Sn ribbon and a sample of Nb 25% Zr wire. The surfaces are defined over the range 2°–18°K, 0–8.5 tesla, and 0–200 amperes, by a direct measurement of transverse critical current. The Nb_3Sn data fit the Kim–Anderson expression over most of the range of variables, and the temperature variation of the critical state parameters A and h_o is determined. The Nb–Zr data fail to fit either Kim–Anderson expressions or the Fietz relation. Author

N68-26258# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
FLUORESCENCE OF DOPED CRYSTALS OF ANTHRACENE, NAPHTHALENE, AND PHENENTHRENE UNDER HIGH PRESSURES: THE ROLE OF EXCIMERS IN ENERGY TRANSFER TO THE GUEST MOLECULES

Peter F. Jones and Malcolm Nicol (Calif. Univ., Los Angeles) Feb. 1968 36 p refs
(Contracts F04695-67-C-0158; AT(11-1)-34)
(TR-0158(9250-01)-1; SAMSO-TR-68-145; AD-668444)

Fluorescence spectra of crystals of anthracene, naphthalene, phenanthrene doped with other polycyclic aromatic hydrocarbons have been studied at pressures as great as 50 kbar. The most significant effects of pressure on the spectra of the host crystals are a loss of intensity of the normal fluorescence with increasing pressure and the almost simultaneous appearance of a broad, featureless emission at energies about 3000 to 6000/cm lower than that of the normal fluorescence. This emission is assigned as the fluorescence of excimers formed upon optical excitation of the crystals under high pressure. The growth of the intensity of the excimer emission with increasing pressure, relative to the intensity of the normal fluorescence, is the same in doped crystals as in pure crystals. The intensities of the guest molecule fluorescences relative to the intensity of the normal host fluorescence in the various doped crystals increase with pressure at about the same rate as the intensity of the excimer emission. These observations are interpreted as indicating that excimers are the lowest-energy excited singlet species of aromatic molecular crystals at these pressures and that, when the excimer concentration is appreciable, the path of energy transfer is from the host via excimers to the guest. Author (TAB)

N68-26300# Frankford Arsenal, Philadelphia, Pa. Pitman-Dunn Research Labs.
OSCILLATOR STRENGTHS OF F AND M CENTERS IN POTASSIUM CHLORIDE
Michael A. Shields Mar. 1968 19 p refs
(M68-21-1; AD-667972)

The optical absorption coefficients and the half-widths of the F and M bands were measured at room temperature in additively colored KCl in which the relative proportions of the color centers were varied by room temperature F-light irradiation. Care was taken to reduce the concentrations of higher aggregate centers by suitable annealing. In interpreting the results, the F center was considered to be a negative ion vacancy with an associated electron and the M center, a pair of F centers in nearest neighbor <110> positions. The slope of the alpha-F vs. alpha-M curve yielded an average value of the ratio of the M- and F-center oscillator strengths, fM/fF = 0.43, in agreement with other measurements. The oscillator strength is the probability of occurrence of the color center optical transition responsible for the absorption peak. An attempt to obtain an absolute value of the F-center oscillator strength by comparing pH and optical measurements is described. Author (TAB)

N68-26320 California Univ., Berkeley.
FAR INFRARED ABSORPTION IN DISORDERED MATERIALS
Walter Alvin Bagdade (Ph.D. Thesis) 1966 130 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8516

A treatment of Schlömann for absorption due to randomized charges in crystals is extended to vitreous materials. In particular, it is noted that for charge defects which contribute independently, the absorption will vary as the square of the frequency at long wavelengths. Measurements of the far infrared absorption in soft glass and fused quartz are presented. In soft glass, the absorption is seen to vary approximately as the square of the frequency for all measurements; in fused quartz, the absorption varies as the square of the frequency above 30 cm^{-1}. The absorption in both materials is roughly independent of temperature between about 20°K. and room temperature. This behavior suggests that the absorption is linked to the disorder inherent in these materials. The absorption of hexagonal crystalline ice in the 10 to 100 cm^{-1} region is presented, and is seen to be characterized by an ω^2 curve. The behavior of the absorption with annealing and change of temperature is reported. It is shown that the Bjerrum type defect involving neutral molecules can lead to disorder induced absorption. The absorption of ice in the 100 to 300 cm^{-1} region is presented. The absorption in liquid water in the 10 to 300 wave number region, at several temperatures, is presented. The absorption is found to increase with increasing temperature. Dissert. Abstr.

N68-26322 Iowa State Univ. of Science and Technology, Ames.
THERMAL CONDUCTIVITY OF MAGNESIUM STANNIDE
Joel Jerome Martin (Ph.D. Thesis) 1967 83 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8925

The thermal conductivity of several n-type Mg_2Sn samples was measured from 4.2 to 300°K. The samples had uncompensated donor concentrations on the order of 2×10^{18} donors/cm^3. Above 150°K, the thermal conductivity showed a T^{-1} temperature dependence which is characteristic of lattice thermal conductivity. The bipolar electronic contribution was estimated to be 4% of the total thermal conductivity at 300°K. Below 100°K, the data were analyzed in terms of the Callaway theory by combining the relaxation times for phonon–phonon scattering, isotope scattering, boundary scattering and bound donor electron–phonon scattering. The calculation in the neighborhood of the thermal conductivity maximum indicated that the only point defect scattering present in the samples was caused by the isotopes of Mg and Sn. At 4°K the data showed a smaller size dependence than the theory predicted if only boundary scattering was included. In addition, the measured values were about half of the curves calculated with only boundary scattering. This result was explained in terms of an additional phonon scattering caused by the bound donor electrons. With this mechanism it was possible to account for the size difference and the difference in doping in the samples. Dissert. Abstr.

N68-26323 Iowa State Univ. of Science and Technology, Ames.
HALL EFFECT OF GADOLINIUM, LUTETIUM AND YTTRIUM SINGLE CRYSTALS
Ronald Stanley Lee (Ph.D. Thesis) 1967 77 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-8921

The Hall effect of gadolinium single crystals has been measured in the temperature range 4.2°–340°K in magnetic fields up to 30 kOe. The Hall effect of lutetium and yttrium single crystals has been measured in the temperature range 8°–320°K in magnetic fields up to 7.8 kOe. For the lutetium and yttrium single crystals the Hall coefficient was measured using an a.c. technique. A large anisotropy and strong temperature dependence of the Hall coefficient was observed in both of these metals. A d.c. method was used to measure the Hall effect of the gadolinium crystals. The magnetic field was applied in the a, b and c directions. R_0, the ordinary Hall coefficient, and R_1, the extraordinary Hall coefficient, were determined as a function of temperature. R_0 is interpreted in terms of changes in the Fermi surface induced by exchange splitting of the conduction bands. R_1 has a ρ^2 temperature dependence below 160°K, where ρ is the electrical resistivity. The deviation from ρ^2 dependence is interpreted as being due to changes in the Fermi surface with temperature. Dissert. Abstr.

N68-26335 Pennsylvania Univ., Philadelphia.
INTERACTION OF DEFECTS IN THE B2 SUPERLATTICE OF BETA BRASS
Stephen George Cupschalk (Ph.D. Thesis) 1966 160 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-7832

The microstructure of β brass has been studied by means of transmission electron microscopy. Specimens quenched from above T_c, the critical temperature for the formation of long range order, exhibited smoothly curved antiphase domain boundaries which are characteristic of the relatively isotropic antiphase boundary energy of the B2 superlattice. Dislocations were observed to

nucleate preferentially at domain boundaries indicating that the boundaries had a strong affinity for vacancies. This interaction was analyzed from the point of view that vacancies possess a lower configurational energy at antiphase boundaries than in the bulk ordered material since they break weak bonds between like nearest neighbor atom pairs there. The formation of dislocation loops is favored at antiphase boundaries because the elimination of a plane of atoms there, by the condensation of excess vacancies, eradicates a portion of the boundary. Specimens quenched from below T_c also indicated a vacancy supersaturation, however, no antiphase boundaries were present. The growth of antiphase domains was analyzed from an atomistic point of view subject to the constraints of the B2 superlattice. Antiphase boundary flattening was also analyzed from the same point of view. Dissert. Abstr.

N68-26336 California Univ., Davis.
TRANSMISSION SPUTTERING OF THIN FILMS BY LOW ENERGY HYDROGEN IONS
Charles Howard Robison (Ph.D. Thesis) 1966 105 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8884

A transmission sputtering experiment was performed with 15 keV molecular ions of hydrogen and deuterium normally incident on polycrystalline gold films several hundred angstroms thick. The sputtered atoms were detected by using neutron activation. A modified form of Pease's sputtering formula was found to fit the data within a factor of two, except in the circumstance where the average range of the primary knock-on atom is less than the displacement energy. The modifications included: the energy loss of the incident particles in passage through the film; the average energy of the moving primary knock-on atoms; and the incident beam scattered before reaching the downstream face of the film. An energy analysis of the sputtered gold ions was attempted for one particular set of parameters using a parallel-plate, electrostatic energy analyzer. Dissert. Abstr.

N68-26337 Brown Univ., Providence, R. I.
NEUTRON IRRADIATION AND THE YIELD SURFACES OF COPPER
Thomas Dixon Dudderar (Ph.D. Thesis) 1966 83 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-2233

Tests were conducted to determine the effects of irradiation and plastic deformation on the yield surfaces of polycrystalline copper. It was found that the principal effect of plastic deformation on unirradiated copper was to translate the yield surface without appreciably changing its size or shape. Irradiation, on the other hand, produced a very large change in the overall size of the initial yield surface; in other words, produced an effect phenomenologically similar to extensive isotropic strain-hardening. In addition, the shape of the initial yield surface after irradiation was dependent on the plastic strain offset chosen to define yield. This effect was not observed for the unirradiated metal. Extensive plastic deformation after irradiation caused the yield surface to translate and grow smaller without significantly changing shape. Dissert. Abstr.

N68-26338# North Carolina Univ., Chapel Hill. Materials Research Center.
RESEARCH ACTIVITIES IN THE FIELD OF MATERIALS SCIENCE Technical Progress Report, 1 Jul. 1966–30 Jun. 1967
1967 65 p refs
(Contract ARPA SD-100)
(AD-668501)

The report comprises brief summaries of materials research projects at the University of North Carolina at Chapel Hill for the year ending 30 Jun 1967. The brief reports of progress in the various individual research programs are arranged by Academic Departments and Schools, and within departments alphabetically by the name of the principal investigator. TAB

N68-26345 Cornell Univ., Ithaca, N. Y.
ULTRASONIC VELOCITY AND ABSORPTION IN KCL CONTAINING Li^+ AND CN^-
Norman Ellis Byer (Ph.D. Thesis) 1966 87 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-6412

Changes in the ultrasonic velocity and attenuation with temperature were measured in KCl containing CN^- or Li^+. The dependence on the acoustic mode, concentration, static uniaxial stress, plastic deformation, and heat treatment was also investigated. The ultrasonic measurements were made by the pulse echo technique. The impurity dependent component of the velocity, δv, in Li-doped samples obeys empirical relation at low Li^+ concentrations. No frequency dependence was observed between 10 and 30 Mc/s. The losses also follow a $1/T$ law and increase monotonically with frequency. The results are interpreted in terms of a classical theory by Nowick and Heller and a quantum theory by Bowen, Gomez, and Krumhansl. In both theories the lack of an interaction with a tetragonal sound wave indicates that the potential wells of the off-center Li ion are along the <111> axes. The temperature and stress dependent of the velocity agree with both theories. The temperature dependence of the losses do not agree with either theory. In KCl containing CN^- the impurity dependent component of the velocity shows a complex temperature dependence. Dissert. Abstr.

N68-26349# Battelle Memorial Inst., Columbus, Ohio.
THEORY OF FERRIMAGNETISM IN INSULATORS Final Report
Richard P. Kenan 6 Mar. 1968 6 p refs
(G-8103; AFOSR-68-0855; AD-668458)

The purposes of this investigation have been to develop, with as much rigor as possible, improved spin-wave theories, to use the theories developed to obtain interpretive formulas for the transition temperature, dispersion curves, and the thermodynamic properties of magnetic insulators, and, somewhat more specialized, to explain the anomalous magnitude of the low-temperature heat capacity of a large number of ferrites, typified by magnetite. There have been three principal accomplishments: (1) A theory of spin-waves in ferrites of arbitrary structure and general exchange constants has been derived; (2) A theory of the effect of statistical interference among spin-waves, resulting from the operation of the Pauli principle, has been developed for a system of spins of magnitude one-half with antiferromagnetic exchange; and (3) A theory of the possible influence of magnetostatic modes of oscillation of the spin system on the heat capacity of ferrites was derived. In addition to these results, research has been carried out and is continuing on the application of functional techniques to the derivation of more reliable spin-wave theories, and on the application of the theory (1), above, to the metamagnetic transition metal chlorides. TAB

N68-26374# Ecole Normale Superieure, Paris (France). Laboratoire de Physique.
PHOTOCONDUCTIVITY SPECTRA OF LOW-TEMPERATURE ELECTRON-IRRADIATED GERMANIUM
J. E. Fischer, J. L. Zizine, and M. Cherki 15 Jan. 1968 13 p refs
(Contract AF 61(052)-67-C-0002)
(Rept.-1968-03; AFCRL-68-0215; SR-3; AD-668470)

Photoconductivity spectrum of n type germanium irradiated at 4 degrees K and 20 degrees K have been measured. An optical quenching phenomena associated with a level at 5.8 microns has been observed in pure sample doped with 3 x 10 to the 13th power Sb/cc irradiated at 4 degrees K with a dose of 5 x 10 to the 14th power e/cm sq of 1.5 MeV. This quenching phenomena disappeared after 90 degrees K annealing. Author (TAB)

N68-26402# Aerospace Corp., El Segundo, Calif. Quantum Electronics Dept.
OPTICAL SPECTRUM OF Cr^{3+} IONS IN SPINELS
P. P. Kisliuk, D. L. Wood, R. M. Mac Farlane, G. F. Imbusch, and D. M. Larkin Mar. 1968 35 p refs
(Contract F04695-67-C-0158; DA-31-124-ARO(D)-208)
(TR-0158(9230-02)-3; SAMSO-TR-68-148; AD-668446)

The optical absorption and fluorescence spectra of two spinels, ZnAl2O4:Cr(3+) and MgAl2O4:Cr(3+), were measured at temperatures between 4.2K and room temperature, and the data are fitted to a crystal field theory that includes spin-orbit coupling and the trigonal field of the D3 site. The parameters for a best fit for both crystals are: Delta = 18,250/cm, zeta = 250/cm, v = -200/cm, v = -1700/cm, and k = 0.7. The (2)E and (4)A2 splittings, observed directly in the ZnAl2O4:Cr(3+) spectrum, are satisfactorily accounted for by the theory. The intensity of the R-lines is shown to be due to magnetic dipole transitions, and fluorescence lifetimes agree well with calculated values. Vibrational sidebands and pair lines observed in fluorescence are identified. Author (TAB)

N68-26414# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
THE OPTICAL SPECTRUM AND ZEEMAN EFFECT OF CaF_2: Eu^{2+}; SEPTEMBER–DECEMBER 1967
Paul P. Kisliuk, Harry H. Tippins, Chester A. Moore and Slava A. Pollack Feb. 1968 28 p refs
(Contract F04695-67-C-0158)
(SAMSO-TR-68-144; TR-0158(9230-02)-4; AD-668443)

New measurements of the Zeeman effect and of the fluorescent lifetime as a function of temperature of Eu(2+) in CaF2 are reported. Estimates of the theoretical parameters are made, and it is shown that neither these estimated values nor the magnetic splitting support those simplified models, used to explain the Faraday rotation, that neglect either the crystal field or the Coulomb interaction between the 5d and the (4f)(6) electrons. Evidence is given that the relative intensity of the Zeeman components in emission is dominated by spin-memory effects rather than by thermalization between the Zeeman levels of the excited state. Author (TAB)

N68-26454 Brown Univ., Providence, R. I.
AN ULTRASONIC STUDY OF THE GENERATION OF HARMONICS IN ALUMINUM SINGLE CRYSTALS
Frank Anderson Sewell, Jr. (Ph.D. Thesis) 1966 118 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-2287

When an initially sinusoidal stress wave of a given frequency and of sufficient amplitude propagates in a nonlinear solid, the fundamental wave distorts as it propagates, and higher harmonics of the fundamental are generated. The anharmonicity of the lattice and the nonlinearity of dislocation displacement are two causes of deviation of the stress–strain relation from Hooke's law. Second harmonic waves attributed to both these causes have been observed. We report here a study of the third harmonic due to dislocation anharmonicity in aluminum single crystals. Because the lattice contribution to the third harmonic in this material is small compared to the dislocation contribution and because of the strong dependence of the amplitude of the third harmonic on dislocation loop length, the third harmonic is particularly suited for studies of dislocation motion under stress and of interactions between dislocations and point defects. Dissert. Abstr.

N68-26480# Air Force Systems Command, Wright-Patterson AFB, Ohio Foreign Technology Div.
INVESTIGATION OF THE ENERGY SPECTRA OF ATOMS SPUTTERED FROM A TUNGSTEN SINGLE CRYSTAL BY MERCURY IONS [ISSLEDOVANIYE ENERGETICHESKIKH SPEKTROV ATOMOV, RASPYLENNYKHIZ MONOKRISTALLA VON'FRAMA IONAMI RTUTI]
M. B. Ben'yaminovich and R. A. Ashmyanskiy 30 Aug. 1967 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk Uz. SSR, Ser. Fiz. Mat. Nauk (Tashkent), no. 2, 1966 p 58–62
(FTD-HT-67-193; AD-668157)

In order to clarify the cathode sputtering mechanism, the sputtering of single crystals was studied with particular attention given to a comparison of conditions required for yielding sputtered particles in various crystallographic directions. TAB

N68-26508# California Univ., La Jolla. Dept. of Physics.
STRAIN EFFECTS IN DILUTE ALLOYS
M. T. Beal-Monod and W. Kohn 1 Mar. 1968 39 p refs
(Contract Nonr-2216(11))
(TR-52; AD-668023)

Impurities in metals give rise to residual resistivity and to electric field gradients. This paper deals with the contribution to these effects by those host ions which are slightly displaced by the impurities. The calculations treat these ions as discrete and give results which are entirely at variance with those of earlier continuum theories. Author (TAB)

N68-26529# Applied Physics Lab., John Hopkins Univ., Silver Spring, Md.
THE THEORY OF MOBILITY, HALL EFFECT AND MAGNETORORESISTANCE IN SEMICONDUCTORS WITH NON-UNIFORM CONCENTRATION OF CHARGED IONS
Yu. V. Kornyushin 30 Jan. 1968 10 p ref Transl. into ENGLISH from Ukr. Khim. Zh. (Kiev), v. 12, no. 8, 1967 p 1327–1330
(TG-230-T-543; AD-668014)

The theory of kinetic phenomena in semiconductors with charged ions is generalized to the case of non-uniform ion concentration. The free-path length of current carriers with respect to thermal vibrations and other scattering mechanisms, excluding charged-ion scattering, is assumed to be much smaller than the Debye screening radius in a semiconductor. The non-uniform charged ion concentration in the general case makes an anisotropic contribution to tensors describing kinetic phenomena in semiconductors. This effect may be considerably greater in value than the effect obtained for the case of non-uniform charged-ion concentration in semiconductors. Author (TAB)

N68-26559 Brown Univ. Providence, R.I.
MAGNETOTHERMAL OSCILLATIONS IN METALS
Bruce Douglas McCombe (Ph.D. Thesis) 1966 157 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-2268

A field modulation phase sensitive detection technique in magnetothermal oscillations, the oscillatory dependence of the temperature of a suitably thermally isolated sample on the inverse of the applied magnetic field, has been used to study Fermi surface-related phenomena in various metals. In this technique a small audio frequency modulating magnetic field is superimposed upon the linearly swept dc field, and the resulting temperature variations of the sample, which occur at harmonics of the modulation frequency, are detected synchronously with the modulating field. Modulating fields both parallel and perpendicular to the static field have been employed. An inverse technique in which the temperature of the sample is modulated and the resulting induced time variation of magnetization is detected by a set of balanced pickup coils has also been investigated. Observed amplitudes of the oscillations in bismuth, antimony, and silver are compared with the theoretically predicted values. Magnetothermal measurements in beryllium have shown striking effects of magnetic interaction. Dissert. Abstr.

N68-26583*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RADIATION DEFECT AND IMPURITY ATOM INTERACTION IN PROTON BOMBARDED SILICON

James B. Robertson, Robert K. Franks, and T. E. Gilmer, Jr. (Va. Polytech. Inst.) 1967 12 p refs Presented at the Meeting of the Am. Phys. Soc., Seattle, 31 Aug.–2 Sep. 1967
(NASA-TM-X-60273) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Test data are presented on the results of proton bombardment of float zone single-crystal silicon in which the major active impurity was boron with a concentration of less than 10^{13} atoms/cc. Crystals mounted on the hot probe reached a temperature of 760° to 870°C due to heating by the proton beam; crystals mounted on the cold probe were water cooled and remained below 90°C during bombardment. Crystals irradiated on the hot probe showed an increase in p-type conductivity and had a series of infrared absorptions with the main peak at 21.1 microns. Crystals irradiated on the cold probe increased in resistivity and showed absorption peaks at 1.8, 3.46, 3.62, 5.5, and 20.5 microns. Possible defect distributions are assessed. It is concluded that the findings show evidence of an association between vacancies and aluminum atoms within the silicon. M.G.J.

N68-26572# Norwegian Defence Research Establishment, Kjeller.
ACOUSTOELECTRIC EFFECTS IN SOLIDS Final Scientific Report, 1 Apr. 1966–30 Sep. 1967
Andreas Rannestad 26 Oct. 1967 13 p refs
(Contract AF 61(052)-958)
(E-113; AFCRL-68-0136; AD-668503)

The report gives a summary of the investigations undertaken during the contract period, and is concerned with the electroacoustic and electrooptic interaction in piezoelectric semiconductors. Particular emphasis has been placed on current saturation and electron drift mobility in CdS and ZnO and the electric field distribution in CdS. Author (TAB)

N68-26595 Minnesota Univ., Minneapolis.
SECONDARY EMISSION NOISE
Clayton Bernard Murray, Jr. (Ph.D. Thesis) 1966 101 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-7763

Shot noise fluctuations have been measured in the secondary emission current of several oxides and metals. The average of the probability distribution for single primaries is commonly denoted by δ and the second moment by χ. It is found experimentally that H saturates at high bombarding energies in both metals and oxides. For most of the bombarding energy range the variance of the secondary electrons is super Poisson. In normal aluminum oxide and magnesium oxide targets χ is determined to be a simple exponential function of primary energy with the exponential obtained from Young's semi empirical theory for the first moment δ of secondary electron emission. While in normal targets the order of magnitude of H and δ is the same, oxide targets exhibiting Malter emission may have values of H four or five order of magnitude larger than δ. By decreasing the work function of polycrystalline tungsten through the deposition of sodium overlayers, one finds that both H and δ increase with the ratio H/δ remaining independent of the work function change. By changing the angle of incidence of the primary beam it is found that above the peak in the yield H increases. Dissert. Abstr.

N68-26603*# Research Triangle Inst., Durham, N. C.
A STUDY OF CHARGE STORAGE IN SILICON OXIDE RESULTING FROM NON-PENETRATING ELECTRON IRRADIATION
M. Simons, L. K. Monteith, and J. R. Hauser Washington NASA Jun. 1968 78 p refs
(Contract NAS1-6900)
(NASA-CR-1088) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Charge storage in silicon dioxide resulting from low energy electron irradiation has been observed. The positive charge build-up has been studied in MOS type structures for various oxide thicknesses as a function of beam energy, electron fluence, sample bias, electrode thickness, and a number of oxide-related parameters. The effective radiation-induced oxide charge appears to be a function of beam energy dissipated within the oxide near the oxide–silicon interface; this charge increases with electron fluence up to a saturation level which was observed in some steam-grown oxides; the experimentally observed dependence of induced charge on applied bias is compared with that predicted by several models for charge accumulation. Optical and thermal annealing of the trapped charge has been studied in an effort to derive information on the nature of the oxide trapping levels. Reduction of trapped charge by irradiation at small negative biases has also been explored. Finally the development of a two-carrier model for space charge build-up in an MOS structure is discussed and the experimental results obtained for silicon dioxide are related to device performance in the radiation environment. Author

N68-26824# Rome Air Development Center, Griffiss AFB, N. Y.
HYDROGEN DOPING AND PARAMAGNETIC PROPERTIES OF IONIC CRYSTALS AT HIGH TEMPERATURES
Raymond A. Serway and Reagan Zogby Mar. 1968 38 p refs
(RADC-TR-68-4; AD-668122)

This report describes the results of a two-phase solid state research program. The first phase was an effort to dope single crystals of the alkaline earth fluorides with hydrogen by diffusion techniques at high temperatures. The techniques used to successfully dope calcium fluoride with hydrogen and the difficulties encountered with cadmium fluoride are described. The second phase of the program was concerned with the measurement of the paramagnetic properties of several ionic crystals as a function of temperature. A possible potential result could be the design of a maser whose operating frequency can be tuned by varying the bath temperature. A high temperature 3 cm wavelength resonant cavity was designed and built, capable of operation up to about 850 degrees K. Electron spin resonance (ESR) data was taken on divalent manganese ions substitutional in calcium carbonate, calcium fluoride, and barium fluoride host lattices. For the case of manganese-doped calcium carbonate, a definite temperature dependence was measured for the hyperfine structure-splitting parameter. In addition, the crystal field-splitting energies were found to be temperature dependent. The temperature dependence of the hyperfine structure splitting was also measured for divalent manganese in CaF2 and BaF2. A discussion of these results in view of recent theoretical treatments is presented. Author (TAB)

N68-26827*# Research Triangle Inst., Durham, N. C.
SEMICONDUCTOR PIEZOJUNCTION TRANSDUCERS
J. J. Wortman Washington NASA Jun. 1968 94 p refs
(Contract NASr-222)
(NASA-CR-1089) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Techniques for utilizing the piezojunction effect as the sensory element in transducers are discussed. A new technique for applying the phenomenon (silicon needle) in a broad class of mechanical transducers has been developed and demonstrated in several transducers. Particular emphasis was placed on accelerometers where it was shown that devices could be fabricated with resonant frequencies greater than 3 KC, capable of measuring ac and dc accelerations in the range from ±1 g to ±100 g. Several techniques were developed for providing a digital output for the piezojunction sensors. Author

N68-26832*# Rensselaer Polytechnic Inst., Troy, N. Y. Nuclear Engineering and Science Dept.
RADIATION-INDUCED PHOTOCONDUCTIVITY OF SILICON
A. H. Kalma and J. C. Corelli [1967] 12 p refs Presented at Santa Fe Conf. on Radiation Effects in Semicond., N. Mex., 3–6 Oct. 1967
(Grant NsG-290)
(NASA-CR-88253) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The photoconductivity induced in zone-refined silicon doped with As, P, and Sb to resistivities in the range of 1 to 100 ohm-cm was studied after bombardment with 1.5 MeV and 45–50 MeV electrons. The dominant defect photoconductivity in all samples irradiated at 45–50 MeV is found to arise from an energy band extending from ≈1.5 μ to ≈4.0 μ. A possible explanation of this energy band is given. Single well-defined defect energy levels dominate the photoconductivity of 1.5 MeV irradiated samples. Using stress-induced atomic and electronic reorientation together with annealing studies and correlating the results with previous electron paramagnetic resonance and infrared absorption experiments, levels located at E_c-0.54eV and E_c-0.39eV are identified as arising from the divacancy defect. Author

N68-28633# Paris Univ. (France). Laboratoire de Physique.
FAST RECOVERY OF ELECTRON IRRADIATED GERMANIUM
J. Bourgoin and P. Baruch 15 Jan. 1968 14 p refs
(Contract F61052-67-C-0002)
(AFCRL-68-0213; SR-1; AD-668468)

The fast recovery of electron concentration after a burst of 1 MeV electrons (1 mA during 15 microsec) has been studied near 100 degrees K, in high purity n-type germanium (10 to the 13th power to 3 x 10 to the 13th power Sb/cc). Three different stages have been observed. (1) A fast decrease (10 microsec) of excess carrier concentration. (2) A further decrease below the initial concentration, during 6 ms. This stage can be attributed to filling of traps either created by irradiation, or grown in the crystal. (3) A return towards the initial concentration, through defect annealing. The time constant, at 100 degrees K, is 24 ms, and the activation energy, near 100 degrees K, is 0.14 eV. This stage appears negligible below 60 degrees K, as expected if it corresponds to the 65 degrees K defect. This behavior can be interpreted with a model based on the creation of a transient defect, stabilized by electronic capture, and then decaying by the usual annealing process. Author (TAB)

N68-28634# Paris Univ. (France). Laboratoire de Physique.
ENHANCED DIFFUSION IN GERMANIUM
A. Brelot 15 Jan. 1968 14 p refs
(Contract F61052-67-C-0002)
(AFCRL-68-0216; SR-4; AD-668471)

The dynamic behaviour of radiation defects at high temperatures (600C) has been investigated by the means of a substitutional impurity enhanced diffusion study. After irradiation it is found that the impurity has diffused much faster than expected from thermal diffusion. This enhanced diffusion appears to be governed by diffusion of excess vacancy created by the irradiation. It is thus possible to measure a defect migration energy and a diffusion length. Author (TAB)

N68-28654# Martin Corp., Baltimore, Md. Research Inst. for Advanced Studies.
ADSORPTION-SENSITIVE MECHANICAL BEHAVIOR
Albert R. C. Westwood, Carolyn M. Preece, and David L. Goldheim Mar. 1968 35 p refs Submitted for publication
(Contract Nonr-4162(00))
(RIAS-TR-68-6C; TR-11; AD-668172)

It has been suggested that certain types of adsorption-sensitive mechanical behavior may be understood, in a general way, by considering the type, concentration, mobility and adsorption-induced redistribution of the charge carriers in the solid. Some recent experimental observations on the embrittlement of AgCl, and Rebinder effects (adsorption-induced reductions in microhardness) in ionic crystals are described and discussed in terms of this hypothesis. Author (TAB)

N68-28658# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
SURFACE PROPERTIES OF MAGNETIC MATERIALS
Progress Report, 1 Mar. 1967–29 Feb. 1968
E. J. Scheibner 29 Feb. 1968 88 p refs
(Contract AT(40-1)-2755)
(ORO-2755-20; PR-8) CFSTI: HC $3.00/MF $0.65

Experimental and theoretical investigations of electron interaction mechanisms in solids and the related physical and chemical properties of solid surfaces are summarized. The dielectric theory of energy losses for slow electrons in solids and a perturbation treatment of single-electron excitations are discussed. Data on characteristic energy losses in Cu and Ni and interpreted in terms of many-particle collective excitations and single-particle interband transitions. An apparatus for determining optical constants, compatible with the LEED system, is described, and the theoretical correlation of optical data with electron energy-loss measurements is explored. Data on the energy distributions of secondary electrons emitted from clean and oxygen-covered Cu surfaces by primary electrons are presented and interpreted on the basis of Auger neutralization of ions at the surface. A summary of theoretical calculations related to the true secondary energy distributions and a discussion of data from graphite and silicon are included. NSA

N68-28664# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THEORY OF NONLINEAR OPTICAL PHENOMENA IN EXTRINSIC SEMICONDUCTORS [TEORIYA NELINEYNYKH OPTICHESKIKH YAVLENIYV PRIMESNYKH POLUPROVODNIKAKH]
V. I. Ponomarenko 18 Aug. 1967 34 p refs Transl. into ENGLISH from Akad. Nauk SSR. Inst. Poluprov. Tr. Resp. Seminara po Kvantovoy Elektron. Kvantovaya Elektron. (Kiev), 1966 p 13–33
(FTD-MT-24-178-67; AD-668049)

The two-photon absorption and the second-harmonic generation in extrinsic n- and p-type semiconductors are theoretically considered. States of electrons are described within the framework of the band theory of solid body; the interaction between radiation and solid-body electrons, is examined (R. Braunstein, Phys. Rev., 1961, 125, 475; R. Loudon, Proc. Phys. Soc., 1962, 80, 952). It is found that the absorption factor of w1 photons is proportional to the intensity of the second beam of w2 -frequency photons. Maximum 2-photon absorption is possible when one of the frequencies is low and the other is close to the frequency that corresponds to the fringe of self-absorption; the effect of 2-photon absorption is stronger in those crystals in which the virtual band lies close to the conduction band. The effect of impurities on the 2-photon absorption (donor and acceptor centers, high and low temperatures, concentration of impurities) is investigated. Generation of the second harmonic is first considered in intrinsic semiconductors (here, the band-structure effect is explored) and then the effect of impurities is evaluated. TAB

N68-28666# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SUPERCONDUCTORS IN PHYSICS AND TECHNOLOGY
V. P. Kartsev 18 Aug. 1967 81 p Transl. into ENGLISH of the book "Sverkhprovodniki v Fizike i Tekhnike" Moscow, Izd. Znaniye, 1965 p 1–48
(FTD-MT-24-109-67; AD-668048)

The popularized booklet discusses the history of low temperature physics; properties of superconductors; the nature of the phenomena occurring at low temperatures; superconducting magnets; and the use of superconductors in power generation, computers and space ships. Author (TAB)

N68-26674# Oak Ridge National Lab., Tenn.
MAGNETIC FLUX FLOW AND SUPERCONDUCTORS STABILIZATION Quarterly Report, 1 Oct.–31 Dec. 1967
W. F. Gauster, K. R. Efferson, J. B. Hendricks, D. M. Kroeger, and M. S. Lubell Mar. 1968 49 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2162) CFSTI: HC$3.00/MF$0.65

Previously reported work has been continued. Extended observations on the flux flow and stability performance of a bare Nb–25% Ti strip showed that for such samples of low heat capacity the value of power dissipation at takeoff has minor significance. More important is the sample current (or more specifically, I^2R_n) and its relationship to the minimum propagating current. The flux flow and stability performance of compound conductors has been studied under controlled heat transfer conditions. An analysis of a great number of test cases showed that the flux flow and stability performance for samples with highly varying copper to superconductor ratios can be quantitatively predicted in a broad range of external fields. Conclusions can be drawn about the temperature–heat flux characteristics of the liquid-helium-cooled short samples employed for these experiments. Efforts to improve the apparatus for direct measurement of heat transfer from small cylindrical metal surfaces to liquid helium have been continued. Finally, work on "thick" thin films is reported. It includes further developmental work on miniature Hall probes and on vacuum deposition and rf sputtering techniques. These techniques will be used for production of thin films for experimental work on superconductivity and on heat transfer. Author (NSA)

N68-26676# Roanoke Coll., Salem, Va. Dept. of Physics.
PROTON SPUTTERING OF POLYCRYSTALLINE GOLD
Charles R. Finfgeld (Ph.D. Thesis) Nov. 1967 65 p refs
(Contract AT(40-1)-3557)
(ORO-3557-3) CFSTI: HC$3.00/MF$0.65

An experiment to determine the yield and angular distribution for sputtering of polycrystalline gold by normally incident protons of energies between 500 eV and 8 keV has been performed. An ion source system delivering a magnetically analyzed proton beam of 1 mA/cm^2 current density to a target at a pressure of 5×10^{-8} torr was utilized. Measurement of the integrated proton current, with correction for secondary electron emission, and determination of the quantities of sputtered gold by neutron activation established the yields. Autoradiographs of the sputtered deposits were used to study the angular distribution. The gold targets, consisting of microcrystals with preferred orientation, were sputtered predominantly on (100) and (110) planes, and the yields were not observed to depend perceptibly on the crystal orientation. The yield was a maximum of 0.014 atoms/proton at a proton energy of 4 to 5 keV, dropping off gradually at higher energies and sharply at lower ones. Analysis of the sputtered deposit spot patterns indicated that focused collision sequences were of greater importance in proton sputtering than in sputtering by heavier ions. Significantly, a readily detectable yield for sputtering by 500-eV protons, which could transfer at most 10 eV to gold atoms in the target, suggests a new, lower sputtering threshold for gold. Author (NSA)

N68-26699# Catholic Univ. of America, Washington, D. C. Dept. of Physics.
ULTRASONIC STUDIES IN ALKALI METALS Final Report
Paul H. E. Meijer, E. V. Mielczarek, and Robert Meister 1 Aug. 1967 6 p refs
(Contract AT(40-1)-2861)
(ORO-2861-5) CFSTI: HC$3.00/MF$0.65

Work performed between June 9, 1961 and August 31, 1966 on ultrasonic studies in alkali metals is briefly summarized. Very pure monocrystalline potassium was prepared. High frequency ultrasonic attenuation was applied to the magnetoacoustic measurement of the Fermi Surface in K. The investigation of cesium and rubidium was started and some successful measurements were made in the determination of sound velocity. Five papers are listed which were published during this period. NSA

N68-26708 Royal Radar Establishment, Malvern (England).
OPTICAL AND ELECTRICAL PROPERTIES OF ZNO MONOCRYSTALS WITH EXCESSIVE ZN
E. Scharowsky [1967] 14 p refs
(RRE-TRANS-165; TIL/OT/8701) CFSTI: $3.00

Nedlelike ZnO crystals which develop through condensation of ZnO vapour at high temperature are heated in Zn vapour to a temperature of 1220°C. Absorption and conductivity measurements are carried out at room temperature with pretreated yellow colored crystals, also their connection with discoloration temperature is examined. Adjusted measurements of the temperature dependence of the conductivity for various grades of discoloration are carried out at a temperature range of 20°–250°C. Quantitative analyses of the absorption and conductivity tests show, that the supplementary absorption is caused by ordinary ionized fault sections (Zn +–Ions). At high percentage of Zn all fault sections are dissociated. Author

N68-26709 Royal Radar Establishment, Malvern (England).
GUNN-EFFECT IN UNI-AXIALLY COMPRESSED GERMANIUM
A. A. Kastal'skii and S. M. Ryvkin [1967] 5 p refs Transl. into ENGLISH from Fik. Tekh. Poluprov. (USSR), v. 1, Apr. 1967 p 622–625
(RRE-TRANS-176; TIL/OT/8703) CFSTI: $3.00

The possibility of creating Gunn instabilities in uni-axially deformed germanium is shown not to contradict the hypotheses. Author

N68-26748# Norwegian Inst. of Tech., Trondheim. Physical Electronics Div.
COUPLED-MODE INSTABILITIES IN VELOCITY SATURATED SEMICONDUCTORS
Tore Wessel-Berg Jan. 1968 76 p refs
(Contract AF 61(052)-907)
(AE-5; RADC-TR-68-161; SR-4; AD-668130)

Field and transport equations are formulated in terms of a particular set of variables which lends itself to a coupled-mode description of semiconductors with carrier drift. The theory is applied to a one-dimensional sample with velocity saturation such as germanium, in which case the electromagnetic as well as the carrier mode are undamped and lossless. Calculations performed at microwave frequencies show that the carrier-mode excitation at the cathode contact is negligibly small for a metallic contact, but may be quite large with a suitably doped n(+) contact. In this case the interaction of carrier mode and total current (EM-mode) in the sample gives rise to a set of coupled-mode instabilities with frequencies specified approximately by nf sub o, where f sub o is the transit-time frequency of the sample, and n is an integer. Under optimum conditions for oscillations the electronic Q of the fundamental mode is of the order of ten. Author (TAB)

N68-26756# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
CORRELATION OF RADIATION DAMAGE TO MATERIALS FOR FFTF
G. E. Russcher and R. E. Dahl Mar. 1968 15 p refs
(Contract AT(45-1)-1830)
(BNWL-567) CFSTI: HC$3.00/MF$0.65

Radiation damage processes which may be critical to FFTF structural materials are the production of high temperature crystal lattice defects such as vacancy clusters or micro voids, extended defects, He production by fast neutron (n,α) reactions with matrix elements, and He generation in steel by slower neutron (n,α) interactions with boron. Though high temperature radiation damage appears related to production of voids or extended defects, current

correlation techniques are based on equating gross displacement defect production in various neutron spectra. Computer simulation of lattice behavior during irradiation and annealing is being used to develop improved correlation techniques. He generation in Ni alloys and stainless steel leads to embrittlement and loss of ductility. Current correlation is based on gross He production. However, agglomerated He atoms probably affect mechanical properties more than the same number of atoms distributed uniformly through the material. Computer simulation of He migration and agglomeration is aimed at providing an improved correlation basis for the effect of He production. Author (NSA)

N68-26768# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RELAXATION OF LOCAL PERTURBATION IN A QUANTUM VIBRATIONAL SYSTEM [RELAKSATSIYA LOKAL'NOGO VOZMUSHCHENIYA V KVANTOVOY KOLEBATEL'NOY SISTEME]
A. P. Purga 16 Aug. 1967 19 p refs Transl. into ENGLISH from Akad. Nauk Estonsk. SSR, Inst. Fiz. i Astronomii. Tr. (USSR), no. 27, 1964 p 57-68
(FTD-MT-24-92-67; AD-668018)

Relaxation of local perturbation in a quantum vibrational system in harmonic approximation is examined. The relaxation of oscillatory energy in an electron-vibrational transition in the impurity center of a crystal is an example of processes of such type. General formulae describing the relaxation of state and energy, localized in the region of perturbation are obtained. In the case of a monatomic chain with isotopic defect calculations of laws of relaxation are reduced to numerical values and presented in the form of graphs. Laws of disintegration have a complex oscillatory form. The result of calculation of relaxation of mean oscillatory energy of impurity atom for the examined model will agree with results of the work of Zavt, where an analogous problem is solved by the methods of classical mechanics. Author (TAB)

N68-26800# Columbia Univ., New York. Henry Krumb School of Mines.
DEFECTS IN CRYSTALS Annual Report, 1 Mar. 1967-29 Feb. 1968
A. S. Nowick Mar. 1968 64 p refs
(Contract AT(30-1)-3712)
(CU-3712-05) CFSTI: HC $3.00/MF $0.65

A relaxation effect due to a single lattice vacancy is studied. Cuprous oxide Cu_2O crystals were chosen for investigation owing to simplicity of the crystal structure, control of defect concentration, use of conductivity to measure deviation from stoichiometry, and availability. Specimen preparations and experimental methods are described. Dielectric and anelastic relaxations of point defects in α-quartz are discussed. Experiments, theories, applications to observed relaxations, and defect reactions in quartz are summarized. An α-quartz doped with aluminum and sodium was chosen for possible experimental observation of piezoelectric relaxation. Methods for calculating slow and rapid relaxation strengths are presented. NSA

N68-26801# Wisconsin Univ., Madison. Dept. of Radiological Sciences.
THERMOLUMINESCENT RESPONSE OF LITHIUM FLUORIDE TO RADIATIONS WITH DIFFERENT LET
Nagalingam Suntharalingam (Ph.D. Thesis) 1967 119 p refs
(Contract AT(11-1)-1105)
(COO-1105-129) CFSTI: HC $3.00/MF $0.65

The supralinear response of lithium fluoride thermoluminescent dosimeters to 50-keV to 33-MeV electrons, 662-keV gamma rays, thermal neutrons, 4.44-MeV deuterons, and soft x-rays is investigated in detail. It is concluded that there are four different radiation quality dependent effects in the thermoluminescence of lithium fluoride: the usual low energy increase in photoelectric cross section, the decrease in supralinearity with increase in LET, the decrease in the response of sensitized phosphor with increase in LET, and the increase in efficiency at low doses with increase in LET. A physical model for the supralinearity is proposed. The changes in sensitivity are accounted for by the elimination of competing mechanisms during irradiation. NSA

N68-26804 Pennsylvania Univ., Philadelphia.
EFFECTS OF SPIN FLUCTUATIONS ON THE PROPERTIES OF TRANSITION METALS
Norman Fredric Berk 1966 139 p
Available from Univ. Microfilms: HC $6.60/MF $3.00

The observed behaviors of the superconducting transition temperature, low temperature electronic specific heat coefficient, and magnetic susceptibility in nearly ferromagnetic transition metals are discussed in terms of a many-body theory which accounts for the effects of spin fluctuations induced by the strong exchange interactions. Mathematically the spin fluctuations are characterized by the electron-hole t-matrix, which is treated within a simplified one-band model that allows electrons to interact via a highly screened, short ranged Coulomb potential. The details of the analytic and numerical analysis are presented. The results show that spin fluctuations contribute a repulsive term to the pairing interaction, which diverges at the ferromagnetic instability and is large enough to totally suppress superconductivity in metals, like Pd, whose susceptibility is strongly exchange enhanced. In addition, spin fluctuations lead to a giant quasi-particle effective mass enhancement, which also diverges at the ferromagnetic instability. Dissert. Abstr.

N68-26809*# University of Southern Calif., Los Angeles. Dept. of Materials Science.
LOCALIZED VIBRATION MODES OF DEFECT PAIRS IN SILICON
V. Tsvetov, W. Allred, and W. G. Spitzer [1967] 8 p refs Presented at a Conf. on Localized Excitation Phenomena, Calif.
(Grant NGR-05-018-083)
(NASA-CR-87761) CFSTI: HC $3.00/MF $0.65 CSCL 20L

This work is an experimental study of Si doped heavily with B and largely compensated with a substitutional donor impurity, i.e., P, As, or Sb. The compensation is completed by diffusion Li. New absorption bands have been observed which can be attributed to B-P, B-As, and B-Sb nearest neighbor pairs. In some cases, notably B-P, the strength of some of the absorption bands depends upon the time and temperature of Li diffusion. This latter effect is interpreted in terms of impurity precipitation. Author

N68-26842# Paris Univ. (France). Laboratorie de Physique.
LOW TEMPERATURE IRRADIATION AND ANNEALING OF N-TYPE GERMANIUM EFFECTS OF OPTICAL BLEACHING
J. Zizine 15 Jan. 1968 16 p refs
(Contract F61052-67-C-0002)
(AFCRL-68-0214; SR-2; AD-668469)

The isothermal recovery of n-type germanium after irradiation by electrons at 20 degrees K is studied by electrical conductivity measurements around 65 degrees K. This study shows that the reaction involved in this temperature range is a diffusion controlled recombination of strongly correlated pairs, thus indicating close vacancy-interstitial pairs. The isochronal recovery of n-type germanium after irradiation by electrons at 20 degrees K is studied by Hall effect and resistivity measurements. Results are discussed. TAB

N68-26857# Wisconsin Univ., Madison.
STARK EFFECT IN COLOR CENTERS OF ALKALI HALIDES
Charles R. Rhyner (Ph.D. Thesis) 1967 71 p refs
(Contract AT(11-1)-1105)
(COO-1105-128) CFSTI: HC $3.00/MF $0.65

The Stark effect of the F center in NaCl, NaBr, KCl, KBr, KI, and RbCl, the M center in KCl, and the Z_1 center in KCl:Sr was measured using an ac electric field. The fractional change of the absorption coefficient, $\Delta\alpha/\alpha$, at the peak of the F band, normalized to a Lorentz local field of 200 kV/cm, was found to be approximately 2×10^{-5} for NaCl and NaBr, 11×10^{-5} for RbCl, and 17×10^{-5} for KCl, KBr, and KI. A simple continuum model is presented which qualitatively relates the effect to the nearest-neighbor separation and an effective dielectric constant. The Stark effect at the peak of the M band in KCl was $3.9\pm0.4\times10-5$ for an applied electric field of 97 kV/cm. A measurement of the change in the absorption coefficient, $\Delta\alpha$, versus photon energy produced a nonsymmetrical curve. This indicates that the effect observed was not the linear Stark effect and thus provides additional evidence that Seitz's model is incorrect. The absorption coefficient increased at energies lower than the M band corresponding to a decrease in the absorption coefficient of the M band. The effect is attributed to the mixing of two nondegenerate energy levels of opposite parity. The optical transition to the level of lower energy is normally forbidden. The Z_1 center in KCl:Sr did not exhibit a detectable Stark effect. It was determined, however, that $\Delta\alpha/\alpha < 8\times10^{-6}$ for an applied electric field of 97 kV/cm. If the Z_1 possesses a permanent dipole moment, the difference between the expectation values of dipole moment in the ground state and excited state is less than 1.0×10^{-20} cgs unit. Author (NSA)

N68-26923 Iowa State Univ. of Science and Technology, Ames.
DOMAIN WALL ENERGY DENSITIES OF FERROMAGNETIC FILMS
Ching-Chao Cho (Ph.D. Thesis) 1967 74 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-8905

The purpose of this investigation was to study the 180° domain wall energy density of ferromagnetic films as a function of thickness in the thickness range from 200 Å to 2700 Å. In the present experiment, films of 81% Ni - 19% Fe composition were deposited on heated glass substrates under vacuum pressure in a magnetic field of about 80 oersted in the plane of the film. A chemical method was then used to etch each film in steps of widths from 0.02 mm to 2.0 mm. Bitter solution was then applied and the film was observed under a microscope. A 60 cps. ac magnetic field of approximately 25 oersted was applied parallel to the easy direction of the film for a full minute; during the following minute, this field was gradually reduced to zero. The results of this experimental technique showed a close similarity to the theoretical derivations of Middelhoek and Brown–LaBonte. Dissert. Abstr.

N68-26946# Joint Publications Research Service, Washington, D. C.
THE EFFECT OF RADIATION ON THE ELECTROPHYSICAL PROPERTIES OF BARIUM TITANATE AND MATERIALS BASED ON IT
S. P. Solov'yev, I. I. Kuz'min, and V. A. Kharchenko 12 Jun. 1968 9 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. (Moscow), v. 31, no. 11, Nov. 1967 p 1757–1761
(JPRS-45638) CFSTI: HC $3.00/MF $0.65

Comparative effects were studied for fast electrons, gamma radiation from Co^{60} and mixed reactor radiation on both monocrystals and polycrystals of barium titanate and related materials. To displace the Ba, O, and Ti atoms in these materials in the $BaTiO_3$ lattice, the bombarding electrons must have energies of 0.85, 0.16, and 0.39 MeV, respectively. Most of the characteristic changes during irradiation can be explained by effects primarily related to the displacement of the oxygen atoms and the corresponding changes in the electron structure of the $BaTiO_3$. Changes in repolarization characteristics observed during irradiation, natural aging, and annealing of irradiated and naturally aged materials apparently result from defect-associated phenomena on both the atomic and submacroscopic levels. M.W.R.

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N68-25664# Defence Standards Labs., Maribyrnong (Australia).
THE ANALYSIS OF FUEL SYSTEM ICING INHIBITORS (FSII) BASED ON ETHYLENE GLYCOL MONOMETHYL ETHER
P. Dunn and A. G. Kelso Mar. 1968 11 p refs
(Rept.-309) CFSTI: HC $3.00/MF $0.65

Quantitative gas chromatographic methods are described for the determination of water in ethylene glycol monomethyl ether (EGME) and of EGME in aviation turbine fuels and in water. The determination of ethylene glycol, glycerol and EGME in aqueous phases associated with such fuels is also described. The methods offer advantages in accuracy, specificity, rapidity and sample size. Author

N68-26526# Monsanto Research Corp., Dayton, Ohio.
INVESTIGATION AND ANALYSIS OF AIRCRAFT FUEL EMULSIONS Final Report, 15 Jun. 1966–14 Jun. 1967
Jay C. Harris and Edward A. Steinmetz Dec. 1967 196 p refs
(Contract DA-44-177-AMC-445(T))
(USAAVLABS-TR-67-70; AD-668248)

The objective of this contract was the development of flammability-controlled JP-4 emulsions for use in gas turbine engines and recovery of JP-4 from the emulsified fuel for forward base usage. The emulsion produced reduced the flame propagation rate to 1/87th that of JP-4 and reduced the area of dynamic burning to 1/6th that of JP-4. Other flame and explosivity tests also showed lower flammability. Tests with metals and elastomers used in fuel systems showed negligible or low emulsion effect. Lubricity tests showed the emulsion to have a coefficient of friction considerably lower than JP-4 alone. Negligible static charge buildup and high conductivity significantly lowered this potential hazard for the emulsion. Although the emulsion can be pumped satisfactorily, it does not flow freely to a sump. The emulsion can very readily be broken chemically: The raw recovered JP-4 contains the emulsifier which can be removed quantitatively by filtration through a column of attapulgite clay. Emulsion partially broken by thermal extremes or by multipassage through a centrifugal pump can be reconstituted by mild agitation. Author (TAB)

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N68-25679*# Colorado State Univ., Fort Collins.
ELECTRIC PROPULSION FOR INTERPLANETARY SPACECRAFT
William R. Mickelson 1967 39 p refs Presented at Am. Astronautical Soc. Symp. on Rocky Mt. Resources for Aerospace Sci. and Technol., Denver, 13–14 Jul. 1967
(Grant NGR-06-002-032)
(NASA-CR-88062) CSCL 21C

Usfulness and competitive status of advanced electric propulsion systems for spacecraft are reviewed, and their potential

performance is compared with the performance of existing flight prototype systems. Features of the advanced systems designed to avoid limitations of existing thrusters and improvements in compatibility with the overall spacecraft system are discussed. The role of new electrostatic and plasma thruster concepts in improving solar-electric primary propulsion systems is examined as well as their compatibility with low-voltage power from future nuclear turboelectric, thermionic, or MHD power plants. Also covered are colloid thruster concepts, electric thrusters utilizing biowaste and spent booster tank material as propellant, and the ATEP system, which combines principles of nuclear rockets and electric propulsion. K.W.

N68-25893# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.

AN ORBITAL MODEL FOR DETERMINING THE IMPULSE NECESSARY FOR INTERPLANETARY FLIGHT [EIN BAHNMODELL ZUR BERECHNUNG DES ANTRIEBSBEDARFES FUER INTERPLANETARE FLUEGE]

Guenter Marx 1 Oct. 1967 73 p refs In GERMAN
(TUB-IR-6/1967) CFSTI: HC$3.00/MF$0.65

Presented are model trajectory diagrams containing the necessary propulsion values for space flights to Mercury, Venus, Mars, and Jupiter as functions of launching and flight times. All trajectories start in a 500 km height Earth orbit and end either in soft landing on the planetary surface or in an orbit of 100 km heights. Ascent and descent trajectories are included; short flight durations (21 to 180 days for the flight to Mars) are considered. Transl. by G.G.

N68-25935*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPLORING IN AEROSPACE ROCKETRY

1967 366 p refs Presented at Lewis Aerospace Explorers Meetings, Cleveland, 1966–1967
(NASA-TM-X-52387) CFSTI: HC$3.00/MF$0.65 CSCL 21H

Details are given on the NASA–Lewis Explorer Post which was initiated to provide promising young men (15 to 19 years of age) with an opportunity for vocational guidance and motivation in the aerospace technical and professional fields. The program format consists of both illustrated technical lectures, and parallel project activities in model rocketry. Designed to put across the basic physical principles and to provide a description of unique analytical and experimental tools, the lectures pertained to the aerospace environment, propulsion fundamentals, calculation of rocket vertical flight performance, thermodynamics, materials, solid and liquid propellant rocket systems, zero gravity effects, rocket trajectories, drag and stability, space missions, launch vehicles, inertial guidance systems, tracking, rocket launch photography, rocket measurements and instrumentation, elements of computers, rocket testing and evaluation in ground facilities, launch operations, nuclear rockets, electric propulsion, and biomedical engineering. Model rocketry projects were directed toward simulating a practical research and development environment. M.G.J.

N68-26310*# Hughes Research Labs., Malibu, Calif.

LIQUID-MERCURY CATHODE ELECTRON-BOMBARDMENT ION THRUSTERS Summary Report, 1 Aug. 1964–31 Oct. 1966

W. O. Eckhardt, H. J. King, J. A. Snyder, J. W. Ward, G. Hagen et al [1967] 111 p refs
(Contract NAS3-6262)
(NASA-CR-54874) CFSTI: HC$3.00/MF$0.65 CSCL 21C

The LM cathode invented as a solution to the cathode life problem of electron-bombardment ion thrusters was developed from a crude laboratory device to a highly efficient and reliable unit. (The LM cathode is basically a gravity-independent, force-fed version of the mercury pool cathode used for many years in mercury rectifiers and other discharge tubes.) Furthermore, the LM cathode was integrated successfully into complete Kaufman-type thrusters, and the cathode durability was demonstrated by a life test which exceeded 5250 hours, with over 4000 hours of in-thruster operation. An ion source efficiency of 75% at a specific impulse of 6400 sec (67% at 3400 sec) was reliably attained. Automatic startup and closed-loop operation was demonstrated during the last 1000 hours of the life test with a prototype mercury feed system which is suitable for use in a flight-type propulsion system. For the last 500 hour test increment the thruster was also equipped with an LM cathode neutralizer. Author

N68-26428# General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.

FEASIBILITY OF BURNING EMULSIFIED FUEL IN A 7LM100 ENGINE

W. W. Stockton and C. M. Olsen Feb. 1968 72 p
(Contract DAAJ02-67-C-0038)
(USAAVLABS-TR-67-74; AD-667902)

Investigations were undertaken for the purpose of developing a safe fuel that will not explode in its stored condition when exposed to a spark, but which will give identical engine performance when used in place of fuels being burned today. The Bell air cushion vehicle engine, a General Electric LM100, was tested on the latest emulsified safe JP-4 fuel. Engine starts and operation were about the same with emulsified JP-4 fuel as with plain JP-4 except that running time was limited on emulsified fuel because of fuel nozzle clogging. Clogging was caused by dirtier-than-normal fuel and by an iron deposit that formed on the fuel nozzles and fuel nozzle screens. Author (TAB)

N68-26488# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EXPERIMENTAL INVESTIGATION OF A TRIPLE-JET GAS EJECTOR [EKSPERIMENTAL'NOYE ISSLEDOVANIYE TREKHSTRUYNOGO GAZOVOGO EZHEKTORA]

Yu. N. Vasil'yev, Yu. A. Zhuravlev, and V. A. Konotop 4 Oct. 1967 19 p Transl. into ENGLISH from Lopatochnyye Mashiny i Struynyye App. Sb. Statey (Moscow), no. 1, 1966 p 217–234
(FTD-MT-24-164-67; AD-668118)

An experimental study was made of a three-jet gas ejector in an attempt to improve ejector efficiency. The three-jet ejector consists of a converging nozzle for the high pressure gas and an annular nozzle for the low-pressure gas, and, is similar to a conventional ejector; it is, however, also equipped with a tube in the center of the converging nozzle through which part of the low-pressure gas is introduced. Plots were obtained for the dependence of the compression ratio on the pressure drop in the forechamber, at various positions of the central tube, and with the converging nozzles having diameter ratios of 0.55, 0.45, and 0.35. The results showed that a compression ratio of 31 and a pressure drop of 240 can be obtained in the three-jet ejector when the outlet of the central tube is located in the minimum pressure zone. This compares very favorably with the 5.6 and 42.5 values obtained in a conventional ejector. By using a start-up control in which the central tube outlet is gradually moved into the minimum pressure zone, a compression ratio of 44 and a pressure drop of 340 can be obtained. The overall results indicate that the operation of a conventional ejector can be substantially improved by installing a central tube for the low-pressure gas. Author (TAB)

N68-26494# National Research Council of Canada, Ottawa (Ontario).

DATA REDUCTION PROGRAM FOR FREE PISTON ENGINE TESTS

F. Rueter Dec. 1967 35 p refs
(NRC-9971; NRC-ME-224) CFSTI: HC$3.00/MF$0.65

A program, written in FORTRAN IV for the IBM 360 computer, for the reduction of data free piston engine tests is described along with a brief description of the engine and its instrumentation, and

the derivation of the various equations used. Input data are in the form of punched cards, and output, in tabulated form, is on the standard line printer. At the option of the user, some of the more important output data may, in addition, be plotted on the EAI dataplotter. Author

N68-26538# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CALCULATION OF THE WORKING PROCESS IN A COOLED GAS TURBINE [RACHET RABOCHEGO PROTSESSA VOKHLAZHDAYEMOY GAZOVOY TURBINE]

G. S. Saprykin 16 Jun. 1967 23 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Energ. (Minsk), no. 6, 1966 p 53–62

(FTD-MT-67-63; AD-668294)

An analytical method is presented for calculating the gas expansion in a cooled gas turbine and for determining the energy losses due to cooling. Formulas are derived which make it possible to determine the actual work, inlet and exit gas temperatures, and the amount of heat lost to cooling. The formulas are sufficiently accurate and are recommended for the analysis and selection of cycle parameters and for designing power plants with high temperature gas turbines. Author (TAB)

N68-26644*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SCREECH SUPPRESSION TECHNIQUES FOR ROCKET COMBUSTORS USING EARTH-STORABLE PROPELLANTS

David W. Vincent, Daniel E. Sokolowski, and Harry E. Bloomer Washington Jun. 1968 38 p refs

(NASA-TM-X-1595) CFSTI: HC $3.00/MF $0.65 CSCL 21H

A rocket investigation was conducted using N_2O_4/50 percent hydrazine 50 percent unsymmetrical dimethyl hydrazine propellants to determine the effects of injector faceplate baffles, concentrated injection distribution with divergent chamber geometry, nozzle entrance length, and injector-element radial coverage. Injector faceplate baffles and concentrated propellant injections were stabilizing. No stability effect was noted by increasing the nozzle entrance length. Creation of an element void at the circumference of an injector was destabilizing. Author

N68-26652# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF CHANNEL VANED DIFFUSER OF CENTRIFUGAL COMPRESSOR UNDER VARIABLE CONDITIONS [ISSLEDOVANIYE KANAL'NOGO LOPATOCHNOGO DIFFUZORA TSENTROBEZHNOGO KOMPRESSORA PRI PEREMENNYKH REZHIMAKH]

N. N. Bukharin 4 Aug. 1967 24 p refs Transl. into ENGLISH from Politekhnicheskiy Inst. Tr. (Leningrad), no. 247, 1965 p 75–85

(FTD-MT-24-122-67; AD-668113)

In centrifugal high-pressure compressors, considerable losses occur in the vaned or ducted diffusor for transforming kinetic into potential energy which is located directly behind the impeller. These losses considerably lower diffusor efficiency. Analysis of the effect of the diffusor geometry on its efficiency was made. It was concluded that minimum losses in the ducts of a vaned diffusor occur at minimum flow rates, while minimum losses in the flow through the impeller occur at maximum flow rates. The diffusor should therefore be designed to minimize the overall losses in both elements. Author (TAB)

N68-26771*# McDonnell-Douglas Co., Long Beach, Calif. Aircraft Div.

A STUDY OF TURBOFAN-ENGINE COMPRESSOR-NOISE-SUPPRESSION TECHNIQUES

Alan H. Marsh, I. Elias, J. C. Hoehne, and R. L. Frasca Washington NASA Jun. 1968 182 p refs

(Contract NAS1-5256)

(NASA-CR-1056) CFSTI: HC $3.00/MF $0.65 CSCL 21E

Preliminary engineering designs of nacelle acoustical treatments applicable to operational jet transports have been studied. The treatments are intended to be used to suppress compressor noise, especially during the landing approach. Studies were limited to the P&WA JT3D turbofan engine series as installed on the Douglas DC-8 airplane; however, the principles developed are applicable to other installations as well. Concepts were investigated involving application of narrow-band resonators and wide-band acoustical absorbers to the walls of the fan-discharge and inlet ducts. The concept of choked engine inlets was also considered. Analytical aerodynamic studies and wind tunnel model tests evaluated inlets with lightbulb-shaped centerbodies to provide narrower duct dimensions, and increased surface area for the addition of acoustical treatment. Tests were run to determine the flow resistance and the normal-incidence acoustical impedance and absorption coefficient of various duct-lining treatment configurations. Author

N68-26805# General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.

INVESTIGATIONS OF A VARIABLE AREA SCROLL FOR POWER TRANSFER IN TIP TURBINE LIFT FAN SYSTEMS Final Report, Jun. 1964–Dec. 1966

Eugene G. Smith Nov. 1967 623 p refs

(Contract DA-44-177-AMC-220(T))

(R67FPD218; USAAVLABS-TR-67-26; AD-667989)

Demonstration tests and analog simulations were performed for the variable area scroll power transfer applicable for thrust control of tip turbine driven lift fans. The tip turbine driven lift fan used the lightweight LF2 rotor. Control response rates of 0.31 second for roll control and 0.10 second for height control were demonstrated. The jazzer, an anticipatory device, improved the response to about one-half the original level. Aerodynamic performance of the system met or exceeded objective levels. Author (TAB)

N68-26865# Purdue Univ., Lafayette, Ind. Jet Propulsion Center.

EVALUATION OF PERFORMANCE CHARACTERISTICS OF A HIGH CHAMBER PRESSURE OXIDIZER-RICH STAGED COMBUSTION GAS GENERATOR

R. L. Strickler and C. F. Warner Feb. 1968 189 p refs

(Contract Nonr-1100(21))

(JPC-442; TM-68-1; AD-668493)

The report describes an experimental investigation of the effects of high stagnation pressures, extremely oxidizer-rich mixture ratios, and various injector configurations on the performance characteristics of a liquid rocket combustor. These environmental conditions can be encountered in the propulsion gas supply for turbopump assemblies on liquid rocket propulsion systems, auxiliary power sources, or working fluid supply on thrust vector control systems. The storable, hypergolic propellants nitrogen tetroxide and a 50-50 mixture by weight of hydrazine and unsymmetrical dimethylhydrazine were selected for investigation. The experimental combustor consisted of a liquid propellant injector, combustion chamber, combustion chamber extensions, combustion gas mixing ring, and nozzle. Four different injectors, all of the liquid-liquid unlike impingement type, were employed in the investigation to examine the performance dependence on droplet size and injector configuration. Stagnation pressures were varied from 1050 psi to 3650 psi. The possible chemical kinetic effects on performance were isolated by varying the mixture ratio from 13 to 24 and employing combustors with significant changes in length. Author (TAB)

N68-26873*# Colorado State Univ., Fort Collins.
ELECTRIC PROPULSION FOR SATELLITES
William R. Mickelsen [1967] 37 p refs Presented at the Am. Astronautical Soc. Symp. on Rocky Mt. Resources for Aerospace Sci. and Technol., Denver, 13–14 Jul. 1967
(Grant NGR-06-002-032)
(NASA-CR-88064) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Electric propulsion is achieving a competitive status for a number of satellite missions. Beyond the present status there are a number of advanced concepts that have promise of higher performance, and consequently a broader applicability to space propulsion. Most of these concepts have features which avoid or diminish fundamental limitations of existing thrusters, and in addition have important advantages in compatibility with the overall spacecraft system. Auxiliary propulsion systems for attitude and position control of satellites and spacecraft must meet exacting requirements for thrust magnitude and direction, and must be compatible with the power supply. Advanced concepts with promise of high performance in meeting these requirements include electron bombardment, radioisotope-heated contact ion, plasma separator, plasma, and colloid thrusters. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N68-25666*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
ON SOLAR X-RAY AND RADIO EMISSIONS FROM THE SUN
S. N. Ghosh Mar. 1968 21 p refs
(Contract NASr-54(05); ORA Proj. 05627)
(NASA-CR-95061; Rept.-05627-19-S) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Assuming a Maxwell distribution of electron velocities in the solar corona, the X-ray fluxes at the earth for temperatures 7×10^5, 1×10^6, 1×10^7 and 1×10^8°K are calculated for free–free transitions. These temperatures correspond to typical cases of completely quiet, quiet, active and flare conditions of the sun. The fluxes are then compared with those for free-bound transitions and line emissions obtained by Elwert and Kawabata. It was shown that during flares, the radiations are emitted primarily by free–free transitions, and that coronal temperatures and electron densities during different types of flares can be precisely determined from observations of solar X-ray emissions. For other conditions of the sun, line emissions predominate, and the spectrum becomes harder and the flux increases as the sun passes from the quiet to active condition. The emission of radio waves by free–free transitions for different conditions of the sun are also calculated and it was shown that the calculated flux for $T=1.10^6$°K and $n_e=10^9$ cm^{-3} is the mean of the observed value for the quiet sun. Author

N68-25676*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
RECENT OBSERVATIONS OF LOW-ENERGY CHARGED PARTICLES IN THE EARTH'S MAGNETOSPHERE
L. A. Frank Jul. 1967 50 p refs Presented at the Summer Inst. on Phys. of the Magnetosphere, Chestnut Hill, Mass., Jun. 1967
(Contract NAS5-2054; Grant NsG-233-62; Contract Nonr-1509(06))
(NASA-CR-88242; Rept.-67-36) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Several recent observations of low-energy proton and electron intensities within the energy range ≈ 100 eV to 50 keV in the earth's radiation zones with a sensitive array of electrostatic analyzers borne on the earth-satellite OGO 3 during mid-1966 are summarized. Measurements of charged particles of the extraterrestrial ring current during a moderate geomagnetic storm, of the low-energy proton and electron distributions in the vicinity of the midnight 'trapping boundary' near the magnetic equatorial plane, and of upper limits for proton and ion (100 eV ≤ E/Q ≤ 50 keV) energy fluxes deep within the inner radiation zone are presented together with several introductory comments concerning the morphology of the omnidirectional intensities of energetic electrons (E ≥ 40 keV, ≥ 230 keV and ≥ 1.6 MeV) at the magnetic equator in the outer radiation zone. Author

N68-25687*# Volt Technical Corp., Washington, D. C.
ON THE ACCELERATION MECHANISM OF PLASMA OUTFLOW FROM THE SUN
M. V. Konyukov Greenbelt, Md. NASA 3 Jun. 1968 32 p refs Transl. into ENGLISH from Russian Publ.
(Contract NAS5-12487)
(NASA-CR-94915; ST-PP-SP-10721) CFSTI: HC $3.00 CSCL 03B

The problem dealt with in this paper consists in finding a mechanism of plasma acceleration up to energies prevailing in the region of earth's orbit. Its selection is based upon the results of quantitative analysis of very simple models of plasma flow from the Sun, provided they meet a series of conditions relative to relationships between solar corona and interplanetary plasma; here laminar conditions of the flux intervene, which allow the fulfilment of the gas-dynamics approximation. Several models are discussed, and within the model utilized it is assumed that the energy for the acceleration of coronal plasma is supplied by a heat source emerging as a result of dissipation of mechanical motions. Author

N68-25688*# State Univ. of Iowa, Iowa City. Physics and Astronomy Dept.
OBSERVATIONS OF LOW ENERGY (≈0.5 MEV) TRAPPED PROTONS WITH INJUN 4
S. M. Krimigis Jul. 1967 32 p refs Presented at the Advanced Study Inst. on Earth's Particles and Fields, Freising, Ger., 31 Jul.–11 Aug. 1967
(Grant NsG-233-62; Contract Nonr-1509(06))
(NASA-CR-89397; Rept.-67-51) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The detector complement of the satellite Injun IV includes a 25 micron totally depleted surface barrier detector with four discrimination levels, two of which are sensitive to protons in the energy interval $0.52 \leq E_p \leq 4$ MeV (channel A) and $0.90 \leq E_p \leq 1.8$ MeV (channel B), and insensitive to electrons of any energy. An analysis of the data for the period 1 March to 17 April 1965 is shown. Author

N68-25710*# State Univ. of Iowa, Iowa City. Physics and Astronomy Dept.
SOLAR PARTICLE OBSERVATIONS INSIDE THE MAGNETOSPHERE DURING THE 7 JULY 1966 EVENT
S. M. Krimigis, J. A. van Allen, and T. P. Armstrong Jul. 1967 32 p refs Presented at the Joint IQSY/COSPAR Sci. Symp., London, 24–29 Jul. 1967
(Grant NsG-233; Contract Nonr-1509(06))
(NASA-CR-89213; Rept.-67-50) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Observations of protons emitted by the 7 July 1966 solar flare at N34, W47 with the low altitude high latitude satellite Injun IV show the following: (1) high energy ($E_p \approx 27$ MeV) protons arrive promptly over the earth's polar caps and decay in a manner consistent with diffusive propagation; (2) the counting rate due to protons in the interval $0.52 \leq E_p \leq 4$ MeV and moving normal to the magnetic vector shows a double plateau as the satellite moves

over the polar caps; (3) the position of the knee for protons in the above energy interval varies from L≈7.5 to L≈8.3 at magnetic local times of ≈4.5 hours and ≈11.5 hours, respectively; (4) after the sudden commencement the latitude gap between trapped protons and solar protons disappears, suggesting that some solar protons may become trapped in the earth's radiation belts; and (5) simultaneous observations with similar detectors inside the magnetosphere (Injun IV) and outside the magnetosphere (Explorer 33) show that low energy (≈0.5 MeV) protons have essentially immediate access from the interplanetary space to the polar caps of the earth. Theoretical implications of these results are discussed. Author

N68-25734*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

DETERMINATION OF THE CORONAL MAGNETIC FIELD AND THE RADIO EMITTING ELECTRON ENERGY FROM A TYPE 4 SOLAR RADIO BURST

Reuven Ramaty and Richard E. Lingenfelter (Calif. Univ., Los Angeles) May 1968 35 p refs
(Grant NSF GP-849)
(NASA-TM-X-63234; X-611-68-208) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The intensity and frequency spectrum of gyro-synchrotron emission from energetic solar electrons radiating in coronal magnetic fields are calculated. These calculations, based on a recent study of the generation of gyro-synchrotron emission in a magnetoactive plasma, are applied to a Type IV radio burst originating at a high altitude in the solar corona. It is shown that the observed frequency spectrum of the burst, which exhibits very sharp low and high frequency cutoffs, can be best understood in terms of gyro-synchrotron emission in an ionized medium and that from the observed frequency spectrum and the ambient coronal density it is possible to deduce both the magnetic field at the site of the emission and the range of electron energies responsible for the burst. Author

N68-25754*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

GUIDING CENTER DRIFTS IN TIME-DEPENDENT MERIDIONAL MAGNETIC FIELDS

Thomas J. Birmingham May 1968 14 p refs
(NASA-TM-X-63229; X-641-68-188) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The problem of a particle trapped in a time dependent meridional magnetic mirror field and at the same time subjected to a time dependent perpendicular electric field, ($E \cdot B = 0$), is considered. Bounce averaged guiding center theory is used to derive expressions for the drift velocity components. These drift expressions depend in a straightforward fashion on the structures of the magnetic and electric fields, and on the particle charge, kinetic energy, longitudinal invariant, and bounce period. In the special case of a static magnetic field, no electric field, and $J = 0$ particles, the drift equations are integrated and the bounce averaged guiding center trajectory obtained. Author

N68-25755*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON THE DYNAMICS OF A CHARGED PARTICLE IN A SPIRAL FIELD

Joseph A. Burns and Gerald Halpern May 1968 29 p refs
(NASA-TM-X-63230; X-641-68-189) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The adiabatic guiding center motion of an energetic charged particle in an idealized representation of the interplanetary magnetic field is discussed. Expressions are presented for all drift velocity components. A comparison of these drifts establishes that, for the cases of physical interest, the electric drift velocity is by far the dominant drift velocity. Considering only the electric drift velocity, an expression is derived for the time of flight of a particle leaving the sun. Similarly it is shown analytically that the particles remain attached to the same field line on which they left the sun; thus indicating their point of origin. High energy unscattered particles are shown to be rapidly channelled down the field lines, resulting in a highly anisotropic particle distribution in the vicinity of the earth. These analytic results are in excellent agreement with numerical integration of complete drift equation and compare favorably with the experimental data. Author

N68-25818*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ELECTRICAL CHARACTERISTICS OF A DC COMPACT ARC IN ARGON FROM 1 TO 10 ATMOSPHERES AND FROM 600 TO 1200 AMPERES

Arthur J. Decker and Gary C. Goldman Washington, D. C. Jun. 1968 9 p refs
(NASA-TM-X-1596) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Voltages across an arc have been measured in argon in the pressure range of 1 to 10 atmospheres (10^5 to 10^6 N/m^2), the current range of 600 to 1200 amperes, and with electrode separation varied from 1 to 2 inches (0.0254 to 0.0508 m). These measurements are summarized in the form of the empirical formula $V = 12.4(LP)^{2/3} - 1.18\ P^{2/3} + 0.0116\ I + 11.7$ expressing arc voltage V as a function of arc current I in amperes, electrode separation L in inches, and pressure P in atmospheres, or $V = 6.67 \times 10^{-2}(LP)^{2/3} - 5.48 \times 10^{-4}\ P^{2/3} + 0.0116\ I + 11.7$ where V is in volts, L is in meters, P is in newtons per square meter, and I is in amperes. Author

N68-25880*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

POLAR CAP ABSORPTIONS AND ASSOCIATED SOLAR TERRESTRIAL EVENTS THROUGHOUT THE 19TH SOLAR CYCLE

Yukio Hakura (NAS) Washington Jun. 1968 28 p refs
(NASA-TN-D-4473) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Solar cycle variations in the emission of high-energy particles from the sun are examined, by using daily Polar Cap Absorption (PCA) indices, selected solar-terrestrial events, and satellite observations of low-energy solar protons. A close relationship between PCA's and type IV solar radio outbursts existed throughout the last solar cycle. The solar corpuscular activity showed three peaks in 1957, 1960, and 1963. The first peak is characterized by a random occurrence of type IV outbursts, PCA's and geomagnetic SSC's (geomagnetic storms with sudden commencement). Active centers were restricted in two parts of narrow heliographic longitudes during the second, the most prominent peak, giving a slight 27-day recurrence to the corpuscular activity. Finally, a pronounced peak of 27-day recurrence appeared during the third period. A recurrent series of solar Mev protons lasted 15 solar rotations, while those of geomagnetic Kp index and galactic cosmic ray intensity lasted 25 rotations. Author

N68-25887# Technische Hochschule Munchen (West Germany).

MEASUREMENTS OF PROTONS IN INNER RADIATION ZONES [MESSUNGEN VON PROTONEN IM INNEREN STRAHLUNGSGUERTEL]

Eberhard Achtermann (Ph.D. Thesis) [1967] 20 p refs In GERMAN CFSTI: HC $3.00/MF $0.65

Rocket measurements on proton flux in the lower boundary layer of the radiation belt are analyzed. Comparison of energy spectra between 1,2 and 80 MeV and in the B, L area $0,168 < B < 0,242$ and $1,44 < L < 1,66$ with earlier obtained observations showed that proton flux decreased with increased height. Variations in low energy protons seem to indicate diffusion from the atmospheric boundary. Transl. by G.G.

N68-25953 Rochester Univ., N. Y.

OBSERVATIONS OF HIGH ENERGY GAMMA RAYS AT THE TOP OF THE ATMOSPHERE

Gerald Harvey Share (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8977

Observations of gamma rays with energies greater than about 50 Mev have been made in the upper atmosphere with a scintillation-Cerenkov telescope at geomagnetic latitudes 41°N and 55°N. Calibration of the telescope was carried out with a tagged gamma ray beam; the results were confirmed by a Monte Carlo calculation. The flux of secondary gamma radiation near the top of the atmosphere was also computed, making possible a prediction of the telescope's response to this flux. Estimates of the extraterrestrial diffuse gamma ray flux were obtained from extrapolation of the data to the top of the atmosphere. The primary flux, arising from decay of neutral pions produced in high energy collisions, was estimated to be $(3.6 \pm 13) \times 10^{-4}$ $\gamma(cm^2\ ster\ sec)^{-1}$. Alternatively, the flux arising from inverse Compton collisions of electrons with starlight and blackbody photons was estimated to be $(4.3 \pm 16) \times 10^{-4}$ $\gamma(cm^2\ ster\ sec)^{-1}$. Dissert. Abstr.

N68-25986*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ESTABLISHMENT OF A LUNAR UNIPOLAR GENERATOR AND ASSOCIATED SHOCK AND WAKE BY THE SOLAR WIND
C. P. Sonett and D. S. Colburn [1967] 15 p refs Presented at the 48th Ann. Meeting of the Am. Geophys. Union, Washington, Apr. 1967 Submitted for publication
(NASA-TM-X-60257) CFSTI: HC $3.00/MF $0.65 CSCL 03B

It is shown that the impact of the solar wind upon a dynamo- and atmosphere-free body such as the moon generates two distinguishable current systems denoted as Cowling ($\vec{B} \neq 0$) and unipolar ($\vec{B} = 0$). The unipolar system representing the steady state must close through the neighboring plasma and thus has the form of a spherical unipolar generator. The relationship of the current to the conductivity of the body is investigated for the homogeneous and the radially inhomogeneous moon. The current density is determined by the power flow in the solar wind and the conductivity of the body. The fundamental equation for the interior potential associated with the unipolar generator is solved for a spherical case. Author

N68-26111 Michigan State Univ., East Lansing.
AN EXPERIMENTAL MEASUREMENT OF COSMIC RAY MUON SCATTERING BY ALUMINUM, IN THE MOMENTUM REGION OF 1.60 Bev/c
Ronald Wilbur Beery (Ph.D. Thesis) 1966 165 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-7520

An account is presented of an investigation into the scattering behavior of $(1.60 + 0.05, -0.04)$ Bev/c $\mu+$ mesons from cosmic rays. The muons were allowed to traverse a spark chamber triggered by a counter telescope. The aluminum plates of the spark chamber provided the scattering material for the incoming muons. Momentum selection was made by using a lead absorber to slow muons having the above momentum, stopping them in a scintillation counter. Final selection of events required observation of a proper μ-e decay signature in oscilloscope photographs made of the signal from the stopping scintillation counter. The narrow limits of momentum obtained and the positive particle-identification procedure represent an improvement over previous cosmic-ray experiments of this kind. The track photographs obtained were measured on semi-automatic scanning equipment. The results of the present experiment demonstrate agreement with both the theory of Copper and Rainwater and of Drell and Schwartz throughout the range of scattering angles observed: 0–4.5 degrees. Dissert. Abstr.

N68-26128*# National Aeronautics and Space Administration, Washington, D. C.
PROTECTION AGAINST SPACE RADIATION
Arthur Reetz, Jr., ed. and Keran O'Brien, ed. 1968 627 p refs Proc. of the Spec. Sessions on Protect. against Space Radiation at the 13th Ann. Meeting of the Am. Nucl. Soc., San Diego, Calif., 11–15 Jun. 1967
(NASA-SP-169) CFSTI: HC $3.00/MF $0.65 CSCL 18F

Conference papers are presented on the basic interaction and transport of space radiation in materials, methods for space radiation shield penetration calculations, spacecraft shield design, and advanced shielding concepts for spacecraft. For individual titles see N68-26129–N68-26153.

N68-26129*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
SPACE RADIATION ENVIRONMENT
Jerry L. Modisette, Joseph W. Snyder, and Richard D. Juday *In its* Protect. against Space Radiation 1968 p 1–17 refs (See N68-26128 15-29)

Current practices in specifying space radiation environments for engineering purposes and the formulation of design approaches are reviewed in terms of protection for man and materials. Attention is given to cosmic rays, solar flare particle events, and Van Allen radiation; and some areas of current activity or controversy are discussed. M.W.R.

N68-26130*# Boeing Co., Seattle, Wash. Missile and Information Systems Div.
CURRENT STATUS OF SPACE RADIATION EFFECTS ON MATERIALS AND COMPONENTS
David L. Dye *In* NASA, Washington Protect against Space Radiation 1968 p 19–32 refs (See N68-26128 15-29)

Space radiation effects are discussed in terms of their interaction with spacecraft materials and components as well as the physical phenomena that give rise to radiation effects. Attention is given to the overall space radiation environment as well as to the various radiation interactions. Effects on materials are considered under the headings of reflective surfaces, thermal control coatings, and photographic films; and effects on electronic components deal with silicon devices in general, transistors, diodes, and solar cells. New questions being raised relate to the combined effects of ultraviolet and particulate radiation on surface materials to be used in vacuo, as well as surface ionization effects in semiconductor electronics. M.W.R.

N68-26132*# Naval School of Aviation Medicine, Pensacola, Fla.
THE LET SPECTRUM OF GALACTIC RADIATION EXPOSURE IN SPACE AND ITS TRANSITION IN SHIELD OF TISSUE
Hermann J. Schaefer *In* NASA, Washington Protect against Space Radiation 1968 p 43–58 refs (See N68-26128 15-29)
(NASA Order R-75)

A comparison is made of flare produced and galactic radiation, and the Linear Energy Transfer (LET) spectrum of primary galactic radiation is discussed. Aspects of the four LET intervals are described; and it is noted that at the fourth interval, which begins at about 100 keV/micron, the ordinary concept of dose and RBE is not applicable. Since there is no experimental data available on total body effects of such exposures to mammalian specimens, the dose fraction of galactic exposure in the fourth LET interval can only be carried in terms of absorbed dose, with the dose equivalent remaining undetermined. The demonstrated microbeam effectiveness on individual cells, however, should caution against disregarding this part of galactic radiation exposure. Transition of LET distribution in the build-up region is considered, along with pseudo build-up of heavy flux components and its manifestation in LET distribution. M.W.R.

N68-26133*# Boeing Co., Seattle, Wash.
SPECTRAL CHARACTERISTICS AND DOSE CALCULATIONS FOR THE PRIMARY AND SECONDARY PARTICLES THAT RESULT FROM THE INTERACTION OF THE SOLAR AND GALACTIC COSMIC-RAYS WITH ALUMINUM SHIELDS
Stanley B. Curtis (Calif. Univ., Berkeley. Lawrence Radiation Lab.) and M. C. Wilkinson *In* NASA. Washington Protect against Space Radiation 1968 p 59–74 refs See N68-26128 Prepared in Cooperation with Calif. Univ., Berkeley, Lawrence Radiation Lab.
(Contract NASw-1362)

The importance of the incident galactic and solar cosmic rays encountered outside the earth's magnetosphere in producing dose is evaluated. It is found that the solar cosmic ray doses are produced principally by protons with energies at the dose point of between 10 and 100 MeV. Galactic cosmic-ray doses result from a broad range of energies, with the principal contribution coming from the 1 to 10 GeV/nucleon region. The medium and high Z components of the galactic cosmic rays are important dose contributors for thin (< 10 gm/cm^2) shielding. Secondary doses depend in a complex way upon the spectral characteristics of the incident particles and the shielding thickness considered. Author

N68-26134*# Air Force Systems Command, Kirtland AFB, N. Mex. Biophysics Branch.
A CORRELATION OF DOSIMETRIC MEASUREMENTS WITH CHARGED PARTICLE ENVIRONMENT OF THE INNER VAN ALLEN BELT
Allen L. Thede and George E. Radke *In* NASA. Washington Protect. against Space Radiation 1968 p 75–92 refs (See N68-26128 15-29)

The radiation research satellite, OV3-4, was to make simultaneous radiobiological and physical measurements in the radiation environment of the Inner Van Allen Belt. Measurements of depth dose rate were made by six specially designed tissue equivalent ionization chambers. These chambers were shielded with basic thicknesses of 0.192 gm/cm^2 aluminum, 0.797, 2.623, and 4.772 gm/cm^2 Lucite and 4.885 gm/cm^2 brass. The charged particle environment was determined by an omnidirectional proton and electron spectrometer using solid state detectors. Results of the proton spectral measurements for energies greater than 15 MeV are presented. Calculated dose rates based on the proton spectral results have been successfully compared with the measured dose rates at points where the electron contribution is negligible. Predicted dose rates were also calculated using the Vette model environment. These values were compared with the measured values and found to be accurate only for thinly shielded chambers. Since the observed proton spectra was much harder than the Vette model, a serious undercalculation or prediction of dose rate resulted for shield thicknesses of greater than 1.0 gm/cm^2. Author

N68-26135*# Avco-Everett Research Lab., Everett, Mass.
THE PLASMA RADIATION SHIELD: CONCEPT, AND APPLICATIONS TO SPACE VEHICLES
Richard H. Levy and Francis W. French *In* NASA. Washington Protect. against Space Radiation 1968 p 93–187 refs (See N68-26128 15-29)
(Contract NAS8-20310)

Fundamentals are detailed for the plasma radiation shielding concept that uses free electron electric and magnetic fields for shielding astronauts from energetic protons produced by solar flares. The nature of the space radiation problem is reviewed, and the need for unconventional lightweight shielding methods is stressed. Basic principles and the basic design parameters of size and voltage are detailed, and it is concluded that the 30 to 60 million volt range is likely to be of interest for plasma radiation shielding. Establishment and control of these voltages is considered a major problem. Restrictions on the configuration of the shielding, and the superconducting coils, vacuum requirements, and other problems are also considered. M.W.R.

N68-26136*# Northrop Nortronics, Norwood, Mass. Applied Research Dept.
THE QUASI-HOLLOW CONDUCTOR MAGNET AS A SPACE SHIELD AGAINST ELECTRONS
S. H. Levine and R. Lepper *In* NASA. Washington Protect. against Space Radiation 1968 p 189–214 refs (See N68-26128 15-29)
(Contract AF 33(615)-1220)

A quasi-hollow conductor (QHC) configuration, studied in a magnetic shield simulator (MAGSIM) provides a protective region appropriately shaped for enclosing a relatively small volume toroidal vehicle. A small volume toroid was constrained to have a large ratio of cross sectional diameter to the radius of the toroid, a configuration which produced for the hollow conductor magnet an outward displacement of the protective volume from the center of the vehicle. By redistributing the current in the QHC design, this displacement was nullified. The presented data were scaled to protect a 10-ft dia space cabin of 420 m^3 volume against space electrons; and the results were used to compute the magnetic fields about the vehicle and the total mass of the active shield system. The magnetic induction produced inside the vehicle by the QHC currents is relatively small except for within a few centimeters of the coils where it increases above 100 and 300 gauss for 2 and 7 MeV shields, respectively. The MAGSIM is an analog device in which the forbidden volume produced by externally deflecting is measured. The most massive component of the QHC active shield is the cryogenic cooling system; and means of reducing heat in this system are considered. M.W.R.

N68-26137*# Ling-Temco-Vought, Inc., Dallas, Tex. LTV Research Center.
ELECTRON BREMSSTRAHLUNG CROSS-SECTION MEASUREMENTS
D. H. Rester and W. E. Dance *In* NASA. Washington Protect. against Space Radiation 1968 p 215–247 refs (See N68-26128 15-29)
(Contracts NASw-1385; NAS8-21055)

Differential cross sections for the production of bremsstrahlung were measured for Al and Au at electron bombarding energies of 0.2, 1.0, 1.7, and 2.5 MeV, and for Cu and Sn at 0.2 and 1.0 MeV. Photon angles ranged from 0° to the largest angle which allowed a reasonable signal-to-background ratio. At 0.2 MeV experimental values were higher than predicted by the Born approximation except in the region below 75 keV. At higher bombarding energies the measured values were closer to the predicted values, reaching good agreement for $Z = 13$ at 1.7 MeV. At all four energies the difference between the measured values and the Born approximation values increased with atomic number. At 1.0 MeV for Al, values were below those reported by Motz at 10° and 30° for photon energies less than 800 keV. For Au at 1.0 MeV, values were below those of Motz for 0°, 20°, and 30° but were in agreement with Motz's values at 90° at this energy. Comparison of the present results for Al and Au at 2.5 MeV agreed within the experimental errors with the results of Starfelt and Koch at 2.72 MeV. Author

N68-26138*# General Dynamics Corp., San Diego, Calif. General Atomic Div.
AN EXPERIMENTAL STUDY OF THE TRANSPORT OF ELECTRONS THROUGH THICK TARGETS
C. P. Jupiter, J. A. Lonergan, and G. Merkel *In* NASA. Washington Protect. against Space Radiation 1968 p 249–283 refs Sponsored by NASA (See N68-26128 15-29)

Experimental methods and results used to study the transport of electrons in thick targets are described, and emphasis is placed on data related to the determination of shielding effectiveness of spacecraft components. Measurements were made of electron transport at incident electron energies of 4.0 and 8.0 MeV to provide data in the energy range where the radiation penetration by

magnetically trapped electrons in the Van Allen belt is most pronounced, and bremsstrahlung measurements were made for an incident electron energy of 10.0 MeV. A magnetic spectrometer was used to determine electron energy spectra for emission angles between 0 and 80° in order to define energy transport in the forward direction; and bremsstrahlung spectra were measured for emission angles up to 40° by a large NaI (T1) crystal spectrometer. Target materials included aluminum and beryllium of thicknesses corresponding to 0.2, 0.5, and 0.7 times the range of the incident electrons. Agreement between these measured data and Monte Carlo angular distribution was generally good. M.W.R.

N68-26139*# National Bureau of Standards, Washington, D. C.
PENETRATION OF ELECTRONS AND ASSOCIATED BREMSSTRAHLUNG THROUGH ALUMINUM TARGETS
M. J. Berger and S. M. Seltzer *In* NASA, Washington Protect. against Space Radiation 1968 p 285–322 refs (See N68-26128 15-29)
(NASA Order R-80)

Monte Carlo programs designed to calculate the transport of fast electrons and associated bremsstrahlung through extended media are described. Two applications are discussed: (1) transmission of electrons through plane-parallel targets, and (2) emergence of secondary bremsstrahlung from such targets. It is shown that the predicted results are in reasonably good agreement with recent experiments for electron beams with energies up to 8 MeV incident normally on aluminum targets. Extensive new calculated data for transmission and thick target bremsstrahlung production are presented for aluminum targets exposed to an isotropic electron flux. Author

N68-26140*# Gulf General Atomic, San Diego, Calif.
THE THEORY OF THE TRANSPORT OF RELATIVISTIC ELECTRONS
Richard Scalettar *In* NASA, Washington Protect. against Space Radiation 1968 p 323–338 refs (See N68-26168 15-29)

A procedure for calculating the transport of relativistic electrons through matter includes inelastic scattering and a correction for large angle scattering; and attains a complete treatment of the coupled spatial, angular, and energy straggling distributions. Actually, the transport equation solution is a superposition of energy straggling distributions appropriately weighted in position and angle. The rapid increase of the eigenvalues associated with the generalized Bethe eigenfunction expansion is shown to make for a good convergence of the series expansion in the flux. The outlined computational procedure is considered to provide a sound basis for the description of the deep penetration of electrons of intermediate relativistic energies. M.W.R.

N68-26141*# Chattanooga State Technical Inst., Tenn.
ANGULAR DISTRIBUTIONS OF THICK TARGET BREMSSTRAHLUNG COMPARED WITH EXPERIMENT
W. Wayne Scott *In* NASA, Washington Protect. against Space Radiation 1968 p 339–358 refs (See N68-26128 15-29)

An approximation, presented for predicting the thick target spectrum which is differential both in photon energy and angle of emission, is derived from the summation of the contribution from successive thin strips into which an absorber is divided. The use of a thin target Born approximation cross section for deriving the thick target expression introduces an error that is unavoidable. A semiempirical relation is given to account for the discrepancy of the Bethe–Heitler equation for use in the thick target relation. Theory of a thick target analysis is discussed, and details are included for the derivation of the thick target equation. Comparisons are made of the theoretically predicted results with experimental data for aluminum and iron targets and electron energies of 0.5 and 1.0 MeV. The approximation is considered particularly useful since the complication of multiple electron scattering within a thick absorber makes a rigorous analytical solution difficult for the prediction of the angular distribution of bremsstrahlung from completely stopped electrons. M.W.R.

N68-26142*# California Univ., Berkeley. Dept. of Nuclear Engineering.
ELECTRON DISTRIBUTION IN A SLOWING-DOWN MEDIUM
Dong H. Nguyen (Texas Univ., Austin.) and Lawrence M. Grossman *In* NASA, Washington Protect. against Space Radiation 1968 p 359–389 refs (See N68-26128 15-29)

The Lewis transport equation of the multiple scattering problem is solved by obtaining the electron distribution in space, energy, and direction of motion resulting from a monoenergetic isotropic plane source in an infinite and homogeneous medium. Validity of the method is demonstrated in the calculation of the electron range-energy distribution, which is in excellent agreement with measurements for aluminum. The presented solution makes use of the small scattering angle approximation to reduce the Lewis equation into a first order partial differential equation in three variables that can be solved by the method of characteristics, and the effect of slowing down is included. The electron transport equation and nuclear scattering cross sections, the reduction of the transport equation to a linear first order partial differential equation, and the electron distribution for a monoenergetic isotropic plane source are discussed. The method can be applied to the two-medium problem in which electrons produced in one medium escape and slow down in the adjacent medium. While it is not limited to an isotropic or spatially uniform source, it is expected than an anisotropic or space-dependent source would complicate the determination of the explicit form of the characteristic curves. M.W.R.

N68-26143*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
A PARAMETRIC TECHNIQUE OF COMPUTING PRIMARY ELECTRON DOSE
Alva C. Hardy, Manuel D. Lopez, and Timothy T. White *In its* Protect. against Space Radiation 1968 p 391–401 refs (See N68-26128 15-29)

A parametric technique for determining interactions of electrons with complex shielding configurations permits the calculation of the primary dose component from fluxes of omnidirectional incident electrons without time-consuming references to transmission data or shielding descriptions. A minimum of computer logic and calculation time is required by the procedure which is applicable to the planning of manned space missions or to analyses of real time data that will not permit references to the electron transport data or vehicle shielding descriptions. Interactions of electrons with matter are discussed in general, and the calculation of electron doses using transmission data is considered prior to the detailed presentation of the parametric procedure. M.W.R.

N68-26144*# Oak Ridge National Lab., Tenn.
HIGH-ENERGY NUCLEON TRANSPORT
R. G. Alsmiller, Jr. *In* NASA, Washington Protect. against Space Radiation 1968 p 403–428 refs Sponsored by NASA (See N68-26128 15-29)

Transport of high energy nucleons through dense matter is considered in terms of space shielding, with the discussion limited to low and intermediate energies and to relatively thin shields. Transport calculations compared with experimental measurements made on thick targets were found to be in agreement at all radii and at the −11.5 cm and 34 cm depths considered in one recent study. First generation secondary particles have been calculated explicitly by Monte Carlo methods and then treated using attenuation factors, but Monte Carlo methods used to solve the transport equations without approximation require lengthy computation. A straight-ahead approximation can be used that assumes that secondary particles are emitted in the direction of the incident particle when a nucleon-nucleus collision occurs. Comparisons between the

exact and approximate calculations for the flare spectrum normally incident on 20 g/cm^2 of aluminum indicates that the straight-ahead approximation overestimates the low energy secondary neutron and proton currents. Data are also included for proton penetration codes written in various approximations. M.W.R.

N68-26145*# Oak Ridge National Lab., Tenn.
NUCLEAR REACTION CROSS SECTIONS FOR SPACECRAFT SHIELD DESIGN
R. W. Peelle *In* NASA, Washington Protect. against Space Radiation 1968 p 429-462 refs Sponsored by NASA (See N68-26128 15-29)

Radiation dose at the center of the sphere can be calculated where the secondary flux from an isotropic primary flux is equal to that obtained in a modified straight-ahead approximation for monodirectional primary protons incident on a slab. Widely available intranuclear cascade-plus-evaporations calculations give secondary nucleon cross sections that agree fairly well with experiments using incident protons; and a model is presented that is considered to have limited validity even for incident proton energies as low as 20 MeV. While the sphere geometry appears to be crude, it is considered adequate for a simple shield representation of the broad angular distribution of secondary radiation. The influence of spacecraft geometry on the relative importance of nuclear secondary cross sections is considered in detail, and cross sections for secondary nucleon production and for secondary gamma rays are presented. It is concluded that the difficulties of spacecraft geometry should not inhibit ever-improving estimations of secondary effects based on the simplest of geometries; and that, in considering secondaries, soft flares must receive the main attention. M.W.R.

N68-26146*# North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
SECONDARY-DOSE EQUIVALENT MODEL AND COMPARISON OF 160-MEV PROTON-INDUCED NEUTRON AND PROTON DOSE WITH A COMPREHENSIVE EXPERIMENT
Bobby Liley and Arthur G. Duneer, Jr. *In* NASA, Washington Protect. against Space Radiation 1968 p 463-493 refs Submitted for publication (See N68-26128 15-29)

A secondary dose equivalent model for calculating secondary proton and neutron doses in arbitrary geometries is described. The random position of origin of the secondary nucleon, primary proton residual kinetic energy and secondary nucleon kinetic energy, and survival weight at the point of generation of the secondary particles are determined by random sampling techniques. When results from this model are compared with the experiment of Maienschein and Blosser which measured the dose from a 160-Mev proton beam incident on an aluminum slab, the agreement is generally better than the state-of-the-art accuracy for secondary dose calculations. Author

N68-26147*# Oak Ridge National Lab., Tenn.
ANALYTICAL REPRESENTATION OF NONELASTIC CROSS SECTIONS AND PARTICLE-EMISSION SPECTRA FROM NUCLEON-NUCLEUS COLLISIONS IN THE ENERGY RANGE 25 TO 400 MEV
R. G. Alsmiller, Jr., M. Leimdorfer, and J. Barish *In* NASA, Washington Protect. against Space Radiation 1968 p 495-515 refs Sponsored in part by NASA (See N68-26128 15-29)

Analytic fits, obtained by the method of linear least squares, to the intranuclear-cascade data generated by H. W. Bertini are given. For both protons and neutrons incident on the elements C, O, Al, Cr, Cu, Ru, Ce, W, Pb, and U, analytic expressions are given for the (1) nonelastic cross section as a function of energy; (2) cascade neutron and proton emission spectra in the angular intervals 0-30°, 30-60°, 60-90°, and 90-180°; (3) evaporation neutron and proton emission spectra, assumed to be isotropic; and (4) cascade neutron and proton emission spectra integrated over all angles. The cascade emission spectra integrated over all angles can be obtained by summing the emission spectra in the individual angular intervals; this procedure, however, leads to functions which involve many more parameters than are necessary, so separate fits for the angle-integrated spectra are given. Author

N68-26148*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PLANE ISOTROPIC BUILDUP FACTORS FOR BREMSSTRAHLUNG CALCULATIONS
Martin O. Burrell and John W. Watts, Jr. *In its* Protect. against Space Radiation 1968 p 517-527 refs (See N68-26128 15-29)

This report presents gamma-ray plane isotropic dose, energy flux, and energy current buildup factors for finite slabs not available until this time. Monte Carlo techniques were used to generate buildup factors for initial gamma-ray energies ranging from 0.05 MeV to 8.0 MeV with six source backings from 0 mfp to 3.0 mfp and for five source-exit plane distances from 0.5 mfp to 7.0 mfp. Differences of up to 50% were found in comparisons with buildup factors generated by the moments method for infinite media. Author

N68-26149*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE CALCULATION OF ELECTRON AND BREMSSTRAHLUNG DOSE RATES
Martin O. Burrell, J. J. Wright, and John W. Watts, Jr. *In its* Protect. against Space Radiation 1968 p 529-538 refs (See N68-26128 15-29)

Two schemes for calculating electron penetration and the attendant bremsstrahlung in spacecraft materials are presented. The first uses the Monte Carlo electron energy transfer data of Berger; and electrons incident on aluminum are considered in terms of transmission and reflection factors for normal incidence as well as isotropic incidence with respect to electron number and energy. The second method, an analytical one, also provides a means of determining bremsstrahlung production. When a straight-ahead assumption for electrons is used, an overestimation of dose rate is obtained. Another equation that assumes the electrons are incident normal to the shield surface is considered more defensible because of the increased attenuation represented by the slant thicknesses of the isotropic integration in a slab geometry. This equation gives a higher dose rate above approximately 1.5 gm/cm^2, while the first one is higher for thin shields; although agreement between the two equations is considered quite good. It is considered logical to assume an isotropic distribution of generated bremsstrahlung as a first approximation to the probable angular distribution. M.W.R.

N68-26150*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
EVALUATION OF GAMMA PROBE SHIELDING VERIFICATION FOR THE GEMINI AND APOLLO VEHICLES
Alva C. Hardy and Joseph W. Snyder *In its* Protect. against Space Radiation 1968 p 539-554 refs (See N68-26128 15-29)

Analytical shielding descriptions were verified for Gemini and Apollo spacecraft by a gamma probe technique that measures gamma ray attenuation to determine the areal electron density between the source and detectors for many positions on the vehicle surface. For thin shields of less than a radiation length, the charged particle penetration is largely determined by interaction with electrons of the shielding material; and the distribution of areal density about a point provides a good approximation of the shielding at that point. A comparison of radiation dosage for the gamma probe and analytical descriptions of shielding geometries for the two spacecraft indicates that conservatively high dose estimates result from the spacecraft descriptions. Spacecraft wiring, small beams, nuts and bolts, and other minute components are neglected in these analytical descriptions; and a weight comparison of the

Gemini analytical description, for example, resulted in about 65% of the true spacecraft weight, indicating that one-third of the actual shielding is overlooked by the analytical shielding method. M.W.R.

N68-26151*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
RADIATION DOSIMETRY FOR MANNED SPACE FLIGHT
Robert G. Richmond, William G. Davis, Joseph C. Lill, and Carlos S. Warren *In its* Protect. against Space Radiation 1968 p 555–580 refs (See N68-26128 15-29)

An operational space radiation dosimetry system containing both passive and active elements was developed for Apollo applications. Active elements include an alpha-proton spectrometer, skin and depth dose rate dosimeters, personal integrating dosimeters, and a portable hand-held radiation survey meter; while the passive components are in the form of several layers of nuclear emulsions and films packaged with a lithium fluoride thermoluminescent powder. A review of Gemini radiation experiences is included, and consideration is given to Apollo needs with regard to crew safety and for low dose monitoring on long duration missions. Each of the Apollo radiation instruments is described and illustrated. M.W.R.

N68-26152*# Air Force Systems Command, Kirtland AFB, N. Mex. Biophysics Branch.
A COMPARISON OF MEASURED TO CALCULATED DOSE FOR THE GEMINI-4 AND 6 SPACE FLIGHTS AND WL-304 SPACE PROBE
Robert L. Stovall, Roger S. Case, Jr., Joseph F. Janni, and Marion F. Schneider *In* NASA, Washington Protect. against Space Radiation 1968 p 581–610 refs (See N68-26128 15-29)

The Space Radiation Environment Shielding (SPARES) computer codes were used to compare radiation doses obtained with a Vette model environment and the Gemini IV onboard spectrometer; and passive dosimetry results aboard the Gemini IV and Gemini VI spacecraft were also summarized. The passive dosimeters were enclosed within five small aluminum canisters. For the low-altitude Gemini flights which intersected the inner radiation zone only through the South Atlantic magnetic anomaly, the dose rates calculated using the Vette environment were consistently high as were the corresponding mission doses. A much better agreement was obtained by calculating the dose rate using the onboard spectrometer data. The dose rates calculated using the Vette environment for the probe which traversed near the heart of the inner radiation zone were in much better agreement with the total calculated dose for the probes first pass through the inner zone being higher than that observed by 50%. M.W.R.

N68-26259# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
A COMPARISON OF 3.3-MM BURSTS AND H α EMISSION
Fred I. Shimabukuro Mar. 1968 20 p refs
(Contract F04695-67-C-0158)
(SAMSO-TR-68-141; TR-0158(3230-46)-11; AD-668440)

Radio bursts observed at a wavelength of 3.3 mm are always associated with flares. The enhancement in the millimeter emission is strongly correlated with some optical event that is associated with the flare. Emissions in the bursts observed thus far, with the possible exception of those associated with proton flares, have not been large increases over quiescent readings and can be explained by a thermal mechanism. Author (TAB)

N68-26348# Oslo Univ., (Norway). Inst. of Theoretical Astrophysics.
ON THE WAVELENGTH DEPENDENCE OF THE BANDWIDTH AND THE DURATION OF TYPE 1 SOLAR RADIO BURSTS
Oe. Elgaroey 1967 5 p refs Repr. from Astrophys. Letters (Glasgow), v. 1, 1967 p 13–14 *Its* Reprint No. 70
(Contract F61052-67-C-0070)
(SR-7(75); AFCRL-68-0204; AD-668390)

On 11 November 1966 storm bursts were recorded simultaneously between 145 and 165 Mc/s and between 315 and 335 Mc/s. From the records the bandwidth of the bursts, defined as the frequency span over which the burst could be discerned from the background continuum, was determined. Constructing histograms of the distribution of bursts of different bandwidths in the two observing ranges, a clear distinction between bursts occurring in the upper and the lower channel was found. In the lower frequency band most bursts had bandwidths between 2 and 6 Mc/s, whereas in the higher frequency band common bandwidths ranged between 4 and 12 Mc/s. The average bandwidths were 3.5 and 7.2 Mc/s respectively. Thus in the case under consideration a connection between observing frequency and burst bandwidth exists. TAB

N68-26514 California Univ., Berkeley.
AN OBSERVATIONAL STUDY OF THE HYDRODYNAMICS OF THE LOWER SOLAR PHOTOSPHERE
Edward Nelson Frazier (Ph.D. Thesis) 1966 117 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-8557

Vertical oscillations with a period of approximately 300 seconds have been observed in the solar atmosphere for several years. This study is an observational investigation of these oscillations in the region of the lower solar photosphere, and of the relation of these oscillations with the underlying convection zone. The observations consisted of a series of high resolution, high dispersion spectrograms taken at the McMath Solar Telescope at Kitt Peak National Observatory. The spectrograms showed the small scale Doppler shifts and intensity fluctuations that are caused by the oscillatory and convective motions. Three absorption lines were chosen for study: Si II λ6371.36, Fe λ6364.38, and Fe λ6355.04. The Si II line is a weak, highly excited line (E. P. = 8085 e.v.), and is formed at an average depth of $\tau_0 \approx 1$. Thus it is expected to be formed in the convection zone itself. The other two lines are formed at intermediate depths extending up to the temperature minimum of the photosphere. Dissert. Abstr.

N68-26530*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
ON THE DISTRIBUTIONS OF LOW-ENERGY PROTONS AND ELECTRONS IN THE EARTH'S MAGNETOSPHERE
L. A. Frank Sep. 1967 53 p refs Presented at the Advanced Study Inst., Earth's Particles and Fields, Stadt Freising, Ger., 31 Jul.–11 Aug. 1967
(Contract NAS5-2054; Grant NsG-233-62; Contract Nonr-1509 (06))
(NASA-CR-89215; Rept.-67-54) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Recent observations of low-energy proton and electron intensities over the energy range $\approx$100 eV to 50,000 eV in the local evening–midnight quadrant of the magnetosphere near the geomagnetic equatorial plane at 5 to 15 R_E (R_E earth radii) geocentric radial distances are summarized with several comments concerning the relationship of these distributions of low-energy charged particles with earlier measurements. Of particular interest are the morphology of the distributions of low-energy protons of the extraterrestrial ring current during magnetic storms, the temporal variations of low-energy electron spectrums in the outer radiation zone and several salient features of the distributions of low-energy electrons in the vicinity of the 'trapping boundary' in the dark hemisphere of the earth's magnetosphere at $\approx$8 R_E geocentric distance near the magnetic equator. Author

N68-26594 Cornell Univ., Ithaca, N. Y.
COSMIC RAY DETECTION BY ATMOSPHERIC FLUORESCENCE
Alan Newton Bunner (Ph.D. Thesis) 1967 209 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-6411

The study of primary cosmic rays above 10^{19} electron volts in energy is of great importance in answering questions concerning the origin of cosmic rays, the physical nature of interstellar and intergalactic space, and the nature of fundamental particle interactions at extremely high energies. New techniques have been sought which can be indirectly sensitive to primary cosmic rays over large effective areas. A technique has been developed which makes use of the luminescence of the nitrogen in the atmosphere to detect the shower of secondary particles generated by a primary cosmic ray at large distances. This radiation, allows the detection of showers which are receding from, as well as approaching, the observer. A study of the feasibility of this technique has involved a detailed examination of the efficiency of air as a scintillator, and the construction and operation of a pilot experimental detector near Ithaca, New York. In principle, the fundamental limitations to the effective area over which a ground-based station can detect this scintillation light are: the inverse square law, atmospheric absorption and scattering, the finite thickness of the atmosphere, and the fluctuations in the night sky light background due to the statistical nature of photoelectron emission. Dissert. Abstr.

N68-26819# Oslo Univ. (Norway). Inst. of Theoretical Astrophysics.
SIMULTANEOUS OBSERVATIONS OF H α AND THE K-LINE OF CA 2 IN THE SOLAR SPECTRUM Scientific Report
Oddbjoern Engvold 1967 15 p refs
(Contract F61052-67-C-0070)
(AFCRL-68-0197; SR-1078; AD-668403)

A simple method for simultaneous observations of the K-line of CaII and the H alpha is described. It is shown that the same technique may easily be applied for other strong lines in the solar spectrum. Author (TAB)

N68-26913# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HIGH-SPEED SURVEY OF PLASMA IN SOFT X-RAY AND ULTRAVIOLET REGION
M. I. Pergament and A. I. Yaroslavskiy 11 Aug. 1967 18 p refs Transl. into ENGLISH from Akad. Nauk SSR, Inst. Atomnoy Energii (Moscow), 1966 p 1–12
(FTD-MT-24-86-67)

As plasma temperature rises its radiation spectrum shifts to the shortwave region which is difficult to study, of special interest is the range of ultraviolet and soft x-ray. High speed survey is a requirement. The authors suggest an electrical-optical converter (EOP) with window for admission of x-radiation. However, it is possible to use a standard EOP if, with the help of a luminophor, the radiation is converted to correspond to the sensitivity of the photocathode, such an arrangement is described. TAB

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N68-25659*# Southwest Center for Advanced Studies, Dallas, Tex.
MARINER 4 AND THE ATMOSPHERE OF MARS
Francis S. Johnson 1967 13 p refs Presented at the Symp. on the Atmospheres of Mars and Venus, Tucson, Ariz., 28 Feb.–2 Mar. 1967
(Grant NsG-269)
(NASA-CR-87682) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Mariner IV data on the Martian ionosphere were variously interpreted in terms of E, F_1, and F_2 regions. Problems exist with each of the interpretations that will not likely be resolved without additional observations. The data that can be expected to be obtained from the Mariner 1969 mission may resolve the question of the appropriate interpretation, but detailed questions will certainly remain—for example, relating to latitudinal variations. Therefore, orbiters should be emphasized over fly-bys in future missions, as their data return should far exceed that of fly-bys and permit far more accurate description of the Martian atmosphere. Author

N68-25685*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMPUTER SOLUTIONS OF THE GRAVITATIONAL N-BODY PROBLEM
Frank Hohl 1967 34 p refs Presented at the Intern. Astron. Union Colloq. on the Gravitational Probl. of N Bodies, Paris, 16–18 Aug. 1967
(NASA-TM-X-60431) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Thermalization effects in a one-dimensional model for a self-gravitating system have been investigated for systems containing low numbers of mass sheets (up to 40). It is found that the fluctuation of the kinetic energy is inversely proportional to the square root of the number of particles in the system. The stability of stationary states for one-dimensional self-gravitating systems is investigated by solving the N-body problem on an electronic computer. The number of "stars" in such systems is large (several 1000) so that the systems can be treated as collisionless. A variational method is used to show that stationary distribution functions that are always decreasing in going outward from the center of the system are stable. For other stationary distributions the system does not represent a minimum energy configuration and the system may be unstable. Computer solutions illustrating the resulting instabilities are presented. Numerical experiments with a simple two-dimensional rod model show that the spiral structure and other filamentary structure of galaxies may result from purely gravitational effects. Author

N68-25708* Naval Research Lab., Washington, D. C. E. O. Hulburt Center for Space Research.
NON-ECLIPSE OBSERVATIONS OF THE F-CORONA
M. J. Koomen and R. Tousey [1967] 22 p refs Presented at the Intern. Symp. on the Zodiacal Light and the Interplanet. Medium, Honolulu, Hawaii, 30 Jan.–2 Feb. 1967 Submitted for publication
(NASA Order R-09-029-036)
(NASA-CR-85621) CSCL 03B

The solar corona from R = 3 to 11 R_s was recorded photographically with rocket borne coromagraphs. Coronal brightnesses were two or more times greater than the model derived from measurements during total solar eclipses. The tentative conclusion was that measurements of the F-corona during a solar eclipse do not record all of the zodiacal light, and that some of the zodiacal cloud may lie between earth and moon where it is shadowed. The rocket coromagraph experiment was repeated. The time selected placed the moon in the field of view, so as to eclipse the K-corona and the part of the F-corona beyond itself, and also cast a shadow into the F-corona between itself and the earth. This time the coronal brightness was lower than previously and in approximate agreement with the model corona. Inspection of the moon's image suggested that little zodiacal material lay between the

moon and earth. Since all coromagraphs had identical optical systems and were prepared, cleaned, and calibrated in the same way, it is tentatively concluded that the variable F-coronal brightness is real and may result from variable quantities of scattering material between earth and moon. Author

N68-25721*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DEVELOPMENT AND UTILIZATION OF A SPACE STATION MISSION SIMULATION MODEL
Karen D. Brender and Charles P. Llewellyn [1967] 43 p refs Presented at the Assoc. for Computing Machinery, 1967 Natl. Conf., Washington, D. C., 29–31 Aug. 1967
(NASA-TM-X-60368) CFSTI: HC $3.00/MF $0.65 CSCL 22A

During the past year, a set of digital programs for the simulation of manned space station missions has been developed. These programs are analytical tools for design analysis and evaluation of such factors as subsystem capability, onboard experimental programs, crew size and skill-mix, logistics system capabilities, major system trade-offs and mission planning requirements. This paper traces the program development and describes a simulation model designed for preliminary analysis of space station missions. A description of the model utilization and the areas in which it is proving to be of greatest value are included. Some results from the use of this model are also presented. The conclusion points out some considerations which have proven to be of importance in the construction of complex simulation models. Author

N68-25742*# Volt Technical Corp., Washington, D. C.
ON THE NATURE OF LIGHT RAYS ON THE MOON [O PRIRODE SVETLYKH LUCHEY NA LUNE]
Yu. N. Lipskiy and V. V. Shevchenko Greenbelt, Md. NASA. Goddard Space Flight Center 5 Jun. 1968 19 p refs Transl. into ENGLISH from Astron. Zh. (USSR), v. 45, no. 2, 1968 p 389–398
(Contract NAS5-12487)
(NASA-CR-94918; ST-LPS-LS-10722) CFSTI: $3.00 CSCL 03B

Comparison of ground observation data with the results of spacecraft photography of the lunar surface leads to the conclusion that the structural peculiarity of light rays is related to the increased concentration of craters with diameter of 800–200 m. A comparative photometric analysis of parts of rays allows us to elicit the availability of "meso-shady" function generated by craters of a given size, and to extrapolate the structural properties of the mentioned morphological category. Author

N68-25764*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MEASUREMENTS OF THE PERTURBED-INTERPLANETARY MAGNETIC FIELD IN THE LUNAR WAKE
Harold E. Taylor, Kenneth W. Behannon, and Norman F. Ness May 1968 29 p refs
(NASA-TM-X-63231; X-616-68-192) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Measurements of the interplanetary magnetic field in the vicinity of the moon made from lunar orbit on the Explorer 35 spacecraft show no shock waves either in front of the moon or within 5.4 R_M behind the moon. The interplanetary magnetic field appears to be convected past the lunar body without much distortion. A regular pattern of magnetic perturbations is observed when passing through the lunar wake. The perturbation amplitude is small and variable, typically less than 30% of the ambient interplanetary magnetic field. Simultaneous measurements made by Explorer 33 while in the interplanetary medium but not in the lunar wake show that even sharp changes in the interplanetary magnetic field are found essentially undistorted in the lunar wake. These simultaneous measurements also help to identify the magnetic perturbation pattern in the wake region. Author

N68-25781*# Carnegie-Mellon Univ., Pittsburgh, Pa.
A THEORETICAL STUDY OF ELECTRIC FIELDS IN THE LUNAR ATMOSPHERE
Richard A. Elco *In* NASA. Goddard Space Flight Center The ASEE–Univ. of Md.–Catholic Univ.–NASA Summer Fac. Fellowship Program Apr. 1968 p 45–62 refs (See N68-25779 15-07)

A collisionless hydromagnetic model of the partially ionized gas flow on the moon yields the ordinary collisionless hydromagnetic fluid equations. Since the solar wind velocity upstream of the moon is supersonic, a shock wave forms on the moon. However, for a steady state shock, the shock must be aligned with the interplanetary magnetic field. The possible geometry of the shock wave is discussed. The maximum increase in the total density and magnetic field across the shock is three times the solar wind values. Therefore, the lunar atmosphere is extremely tenuous, having a total particle density of no greater than 50/cm^3. Space charge electric fields in the lunar ionosphere are two orders of magnitude smaller than the $V \times B$ electric fields which are the order of ten millivolts per meter. Author

N68-25790*# Techtran Corp., Glen Burnie, Md.
MICROMETEORITE RESEARCH ON THE COSMOS-135 SATELLITE [MIKROMETEORNYYE ISSLEDOVANIYA NA SPUTNIKE 'KOSMOS 135']
B. P. Konstantinov and M. M. Bredov Washington NASA May 1968 21 p refs Transl. into ENGLISH from USSR Acad. of Sci., Order of Lenin Phys.-Tech. Inst. Im. A. F. Ioffe (Leningrad), 1968 33 p
(Contract NASw-1695)
(NASA-TT-F-11753) CSCL 22A

An improved acoustical apparatus was used on the satellites Cosmos-135 and Cosmos-163 to make more accurate measurements of dust particle densities in near-earth space. The improved apparatus, which was largely protected from the influence of noise resulting from thermal expansion of the detectors and the satellite, recorded dust flux values three orders of magnitude lower than those recorded by earlier apparatus, but in good agreement with dust density values estimated from zodiacal light and other American and Soviet satellites which had determined dust particle densities by actual penetration of thin barriers. The authors conclude that the hypothesis of the existence of a dust cloud around the earth is false. Author

N68-25807*# GCA Technology Div., GCA Corp., Bedford, Mass.
PLANETARY METEOROLOGY Final Report
George Ohring, Wen Tang, Joseph Mariano, and Gloria de Santo May 1968 57 p refs
(Contract NASw-1574)
(NASA-CR-94964; GCA-TR-68-4-N) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The thermal equilibrium model for computing vertical temperature profiles in the Martian atmosphere is expanded to include water vapor radiative processes. Calculations with this model show that the observed small amount of water vapor in the Martian atmosphere ($\approx 10\mu$ percipitable water) does not significantly affect the computed temperature profile. Thermal equilibrium calculations of the mean surface temperature and mean vertical temperature profile on Mars indicate that the temperatures are relatively insensitive to variations in surface pressure and carbon dioxide abundance. The mean Martian surface temperature is computed to be 216°K, indicating a greenhouse effect of 8°K. Two models for calculating diurnal variations on Mars are developed. The first model is for calculation of diurnal variations of temperature and includes radiative and eddy heat transfer in the atmosphere and molecular conduction in the soil. The second model is for calculation of the diurnal variation of temperatures and winds. Author

N68-25812*# Applied Analysis, Inc., Huntsville, Ala.
ROBOT. APOLLO AND AAP PRELIMINARY MISSION PROFILE OPTIMIZATION PROGRAM. PART 1: MATHEMATICAL FORMULATION
Robert G. Gottlieb NASA. Marshall Space Flight Center May 1968 109 p refs
(Contract NAS8-20082)
(NASA-CR-61223) CFSTI: HC$3.00/MF$0.65 CSCL 22A

ROBOT is a minimum Hamiltonian steepest ascent multistage booster trajectory optimization program. It can simulate up to 15 thrust or coast events, provide rigorous Saturn V and Saturn-IB ground launch simulation and can also be started in orbit. The payoff and terminal constraints can be selected from a library of eleven functions. In addition intermediate point constraints, selected from the same library, may be imposed on the trajectory following any one of the thrust events. Through the use of input switches, a variety of vehicle parameters can be optimized in conjunction with the control variables χ-pitch and χ-yaw. Tanks limits of stages being optimized can be held and performance reserves, as a function of ΔV, can be calculated. The impact point of any stage can be calculated and publishable tables can be printed. The working coordinate system and the environmental simulation conform to Apollo standards. Author

N68-25823# Joint Publications Research Service, Washington, D. C.
ASTRONOMY
In its Soviet Bloc Geophys., Astronomy, and Space, No. 181 6 Jun. 1968 p 1–10 refs Transl. into ENGLISH from various Russian articles (See N68-25822 15-13)

News reviews and abstracts of scientific articles on astronomy are presented from the Soviet-bloc literature. A general article covers astronomy gains in the USSR, and the theory of planetary origins is considered. Scientific research reviews deal with luminosity function and star density near the sun, solar radiation measurements, and altitudes of isobaric surfaces after solar flares. Observed CO lines in the solar spectrum are discussed, as are radio emission spectra of solar regions, sunspot catalogs, solar corona structure, chromospheric spicules, and magnetic fields of sunspots. M.W.R.

N68-25833# Washington Univ., Seattle.
WHAT THE LUNAR SURFACE CAN TELL US ABOUT THE EARLY HISTORY OF THE EARTH'S SATELLITE SYSTEM
Nils Aall Barricelli and Ralph Metcalfe [1968] 32 p refs

The hypothesis that most lunar craters and some of the maria are the result of impacts by meteors and larger celestial bodies colliding with the moon has long been a favorite interpretation of these features. If this hypothesis is correct, many of the structures visible on the lunar surface may be the result of early collisions with other Earth satellites. A method to discriminate between surface structures due to satellite impacts and other impacts is proposed, and several implications concerning the early history of the moon and the satellite system of Earth are presented. An interpretation of the predominance of maria on the side of the moon which presently faces towards the Earth and their absence on the far side is obtained by considering that the moon's distance from the Earth has been steadily increasing in the last few billion years. Under these conditions collisions with Earth satellites moving in orbits external to the moon's own orbit are likely. The effect this may have on the distribution of maria is considered. Author

N68-25836*# Massachusetts Inst. of Tech., Cambridge. Soil Mechanics Div.
LUNAR SOIL MECHANICS, 1966–1967
Apr. 1968 115 p refs
(Grant NsG-496)
(NASA-CR-95060) CFSTI: HC$3.00/MF$0.65 CSCL 03B

The purpose of this study is to outline the contributions soil engineering can make in lunar exploration, to indicate soil engineering problems and techniques for their solution, and to propose a lunar soil mechanics research program. The problems that are discussed include soil foundations, mobility, and slope stability. Specific site studies, classification parameters, and correlation techniques are examined in connection with the proposed research program. K.W.

N68-25837# Smithsonian Astrophysical Observatory, Cambridge, Mass.
FORMATION OF THE CALCIUM H, K, AND SUBORDINATE LINES IN THE SOLAR CHROMOSPHERE, VOLUME 1
Jeffrey L. Linsky 13 May 1968 79 p refs
(SAO-SR-274, V. 1)

Line transfer solutions in physically meaningful chromospheric media were considered without the transfer of local thermodynamic equilibrium. The process of analyzing the calcium II resonance was actually combined with that of finding subordinate lines in terms of self-consistent model chromospheres. Source function equations were obtained when the lines were coupled together in a four level representation of the calcium ion and when the ionization equilibrium was governed by the solar ultraviolet radiation field. Statistical equilibrium of atomic level populations were treated; and hydrostatic equilibrium and ionization equilibrium of the metals and hydrogen were considered in the context of model chromospheres. The method for computing these chromospheres is given, and the adopted solar protosphere and upper chromosphere and a detailed description of the model chromospheres are included. M.W.R.

N68-25838# Smithsonian Astrophysical Observatory, Cambridge, Mass.
FORMATION OF THE CALCIUM H, K, AND SUBORDINATE LINES IN THE SOLAR CHROMOSPHERE, VOLUME 2
Jeffrey L. Linsky 13 May 1968 138 p refs
(SAO-SR-274, V. 2)

Local thermodynamic equilibrium (LTE) was considered and the CaII/CaI and CaIII/CaII ionization equilibria computed for a representative chromospheric model. Collisional and radiative rates among the CaII levels that enter directly into the source function equations were evaluated, as was the abundance of calcium in the sun and the broadening mechanisms that contribute to the calcium line profiles. Consideration is given to the improvement of an assumed temperature-height distribution in order to obtain agreement between the resulting and an observed profiles, assuming a fixed variation of turbulent velocities. A direct procedure is included that uses the H matrix. The computer program for making such calculations is detailed. The first overlay includes the model chromosphere calculation; the second overlay covers the source function equations, height integration, and calcium ionization equilibria; and the third overlay deals with emergent profile and temperature correction procedures. M.W.R.

N68-25839# Smithsonian Astrophysical Observatory, Cambridge, Mass.
FORMATION OF THE CALCIUM H, K, AND SUBORDINATE LINES IN THE SOLAR CHROMOSPHERE, VOLUME 3
Jeffrey L. Linsky (Ph.D. Thesis) 13 May 1968 89 p refs
(SAO-SR-274, V. 3)

Calcium H and K lines with high spectral purity were observed from small homogeneous regions on the solar disk and within the expected time scale in which these regions change in both quiet and active chromospheres. Stray light, roughly 25 times as bright as the cores of these lines, were reduced to negligible values; and the emergent solar profiles were unmodified by instrumental resolution through the use of dispersion. Numerical experiments with representations of the CaII ion were performed, and the theoretical $I(K_3)/I(H_3)$ ratio was considered. Implications of an extended

temperature minimum region with T_0=4600°K are presented, the consequences of limb darkening on the proposed representation of the solar chromosphere are noted, and unresolved questions concerning the calcium lines are considered. The thermal structure of the solar chromosphere is described in terms of the temperature minimum region as well as above the temperature minimum. M.W.R.

N68-25867*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LOCAL-ERROR CONTROL AND ITS EFFECTS ON THE OPTIMIZATION OF ORBITAL INTEGRATION
C. E. Velez Washington Jun. 1968 24 p refs
(NASA-TN-D-4542) CFSTI: HC $3.00/MF $0.65 CSCL 22C

In the numerical integration of orbits by a multistep process, it has been suggested that the application of a local error control may increase the efficiency of the integration without any significant loss of accuracy. This study develops methods of controlling the local error and examines the effects of these controls on the integration. It is shown that for various orbit types, controlling the local error can optimize the integration while maintaining the desired accuracy. Author

N68-25872*# Hawaii Univ., Honolulu. Haleakala Observatory.
A PROGRAM OF GROUND-BASED STUDIES OF THE ZODIACAL LIGHT
J. L. Weinberg 1967 15 p ref Presented at the Intern. Symp. on the Zodiacal Light and the Interplanet. Medium, Honolulu, Hawaii, 30 Jan.-2 Feb. 1967
(Grants NsG-676; NSF GA-326)
(NASA-CR-87730) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Nonzodiacal light sources of appreciable polarization in the nightglow are discussed, with particular mention made of the polarization associated with the 6300 Å and 5577 Å airglow line emissions. The origin of this polarization is discussed, and a figure is included to show that the diurnal variation of the plane of polarization at 5080 Å is primarily associated with the zodiacal light and the changing position of the sun with respect to the observer and the celestial pole. The polarization at 5577 Å is not solar-oriented, and preliminary calculations suggest that such polarization may be explained by tropospheric scattering of an unpolarized radiation incident on the scattering atmosphere from the E and/or F regions. Methods of separating the zodiacal light from starlight and airglow are assessed. An empirical technique for deriving the starlight is illustrated by plotting the observed brightness at 5300 Å for part of an almucantar including the peak zodical light and regions of both high and low galactic latitude. It is pointed out that airglow line emission can be avoided by careful selection of the filters. Observations of Comet 1965f and the zodiacal cloud, and lunar libration clouds are mentioned. M.G.J.

N68-25873*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
IMPLICATIONS OF MICROWAVE SPECTROSCOPY FOR THE WATER-VAPOR CONTENT OF THE VENUS ATMOSPHERE
J. B. Pollack and A. T. Wood, Jr. May 1968 13 p refs
(Grant NGR-09-015-023)
(NASA-CR-94926; SAO-805-44) CFSTI: HC $3.00/MF $0.65 CSCL 03B

From a comparison of theoretical and observed microwave brightness temperatures of Venus at 1.35 cm, the center of a water-vapor line, we obtain an upper limit of 0.8 percent to the water-vapor mixing ratio in the lower atmosphere. This limit is consistent with the amount of water vapor detected by Venera 4, the existence of water ice clouds, and a greenhouse effect caused by water vapor and carbon dioxide. The computed spectra suggest that a sensitive procedure for detecting water vapor is an examination of the 1-cm to 1.4-cm wavelength region. Author

N68-25884*# New Mexico State Univ., Las Cruces. Observatory.
POLARIMETRY OF ULTRAVIOLET CLOUDS ON VENUS
B. A. Smith Apr. 1968 6 p ref
(Grants NsG-142-61; NGR-32-003-027)
(NASA-CR-95032; TN-701-68-22) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Differential polarization of ultraviolet light across the disk of Venus is found to be insufficient to support Kuiper's scattering-absorption model for cloud visibility. Author

N68-25895*# Arizona Univ., Tucson.
MULTISEGMENTED OPTIMAL TRAJECTORIES
Thomas L. Vincent Washington NASA Jun. 1968 31 p refs
(Grant NsG-580)
(NASA-CR-1103) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The problem of Bolza from the calculus of variations in terms of modern control notation has been extended in scope to include situations in which a number of subarcs in the state variable trajectory may occur in a variety of ways. The subarcs are allowed to be overlapping and/or separated. This allows for several subarcs to occur in the same interval of the independent variable and for subarcs which are separated by jumps in the independent and state variables. In addition, the differential equations of constraint and the integral quantity to be extremized are allowed to be of different form from subarc to subarc. The necessary minimizing conditions for the extended Bolza problem are obtained by extremizing a new functional which is related to it. This allows the optimizing conditions for the state and control variables to be obtained by applying the usual calculus of variations procedures and the optimizing conditions for the endpoints of the subarcs to be obtained using the ordinary theory of maxima and minima. Author

N68-25902*# Michigan Univ., Ann Arbor.
TRAJECTORY OPTIMIZATION BY A DIRECT DESCENT PROCESS
L. E. Fogarty and R. M. Howe Washington NASA Jun. 1968 38 p refs
(Grant NASr-54(06))
(NASA-CR-1070) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The problem considered is that of trajectory optimization using step-by-step descent to minimum cost along the direction of the cost gradient with respect to the control. Using a hybrid computer, the gradient is computed directly as the response to nearly impulsive control perturbations. A method is presented for computing the gradient when several terminal constraints are enforced. Examples of application of the method are presented. It is concluded that the direct gradient computation method has some significant advantages over other methods. Author

N68-25928*# Massachusetts Inst. of Tech., Cambridge. Electronic Systems Lab.
ON THE OPTIMAL ANGULAR VELOCITY CONTROL OF ASYMMETRICAL SPACE VEHICLES
Atif S. Debs and Michael Athans May 1968 13 p refs
(Grant NGR-22-009-124)
(NASA-CR-94924; ESL-P-335) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The problem of reducing the angular velocities of a space vehicle to zero is considered. The required control torques are found as functions of the angular momentum. Linear and nonlinear time-invariant feedback control systems are determined. The method of solution is based on the inverse problem of optimal control. B.S.D.

N68-25929*# New Mexico State Univ., Las Cruces.
MARS MARINER 4: IDENTIFICATION OF SOME MARTIAN SURFACE FEATURES

Bradford A. Smith and J. C. Robinson Apr. 1968 11 p refs
(Grants NsG-142-61; NGR-32-003-027)
(NASA-CR-94925; TN-701-68-21) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Several frames of the Mariner-IV picture series show one or more features of sufficient size to be recorded on telescopic photographs taken from the earth during 1965 and 1967. The variability of certain martian surface markings has hindered earlier efforts to identify the Mariner features with those on published maps of Mars. Recognition here includes features in the Propontis-Hades-Phlegra complex, a small oasis, and the border between Zephyria and Mare Sirenum. Author

N68-25938 Michigan Univ., Ann Arbor.
RELATIVISTIC OPTIMAL ROCKET TRAJECTORIES FOR INTERSTELLER TRAVEL
Gerald Marshall Anderson (Ph.D. Thesis) 1966 277 p
Available from Univ. Microfilms: HC $12.60/MF $3.60 Order No. 67-8204

The purpose of this study is to investigate thoroughly the characteristics of one-dimensional relativistic minimum time and minimum fuel trajectories of single-stage rockets, with emphasis on possible application to interstellar travel. Control constraints of rocket acceleration limiting and thrust limiting are considered. Brief reviews of special relativity theory, general relativity theory, and relativistic rocket mechanics are presented. Then the problems to be covered are discussed, along with the assumptions made in these analyses. The analyses of the minimum time and minimum fuel problems for acceleration limited rockets and for thrust limited rockets are then presented. For each of these problems, the relativistic optimal control law is found and compared with the results from the equivalent Newtonian problem. Assuming trajectories with zero initial and zero final velocities, the characteristics of optimal interstellar trajectories are determined and compared with the equivalent Newtonian results. Based on assumptions on acceleration, mass ratio, and flight time limitations, these characteristics are used to examine the applicability of various types of rockets to interstellar travel. Dissert. Abstr.

N68-25975# Joint Publications Research Service, Washington, D. C.
DOCKING IN SPACE A COMPLEX PROBLEM
Yu. Novikov and B. Fedorov 12 Jun. 1968 8 p Transl. into ENGLISH from Aviats. i Kosmonavt. (Moscow), Feb. 1968 p 53–56
(JPRS-45653) CFSTI: HC $3.00/MF $0.65

The techniques used for the automatic docking of the Cosmos-186 and Cosmos-188 are discussed, and the overall problems inherent in docking orbiting spacecraft are examined. It is pointed out that in order for docking to be accomplished, the spacecraft must be guided to the area where their radar and other onboard equipment can provide mutual search and detection. Three possible positions for rendezvous of spacecraft in the docking area are identified: (1) when both spacecraft are orbited simultaneously (simultaneous launch); (2) when one is already orbited, and the second is placed in orbit; and (3) when both spacecraft are already in orbit. Preference is given to the second method when it is possible to determine the orbit of a vehicle launched earlier. Completely automatic docking, in comparison to docking performed with the participation of man, involves additional difficulties. Specialized and complex radio equipment and computers are required for automatic control of the spacecraft. Automation of the processes of approach and docking of spacecraft is considered to be necessary for the solution of future problems in the mastery of space. A.L.

N68-25976# Defence Research Board, Ottawa (Ontario).
RE POLYGONALITY AND IRREGULARITIES OF SHAPE OF CERTAIN LUNAR CRATERS
V. D. Davydov Apr. 1968 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 178, no. 4, 1968 p 797–799
(DRB-T-491-R) CFSTI: HC $3.00/MF $0.65

The development history and periodicity of the quasipolygonal relationship between moon crater radius and azimuth is studied by analyses of lunar emission spectra as recorded by orbiter Luna-10. Comparison of the intensity of the components from the decay of the natural radioactive elements K^{40}, Th, and U with concentrations of these substances in terrestrial rocks established a structural similarity with basalt type rocks. Since polycrystalline basalts are anisotropic within the body of each crystal, the deformation in a shock wave is incompletely transmitted from one basaltic unit to the next through their contacting faces. This anisotropic distribution of the explosive energy causes the difference in crater radii. G.G.

N68-25978*# Exotech, Inc., Washington, D. C. Systems Research Div.
TECHNICAL MANUALS AND PLANNING STUDY IN PLANETARY QUARANTINE Final Report, 9 Aug. 1967–8 May 1968
May 1968 17 p refs
(Contract NASw-1666)
(NASA-CR-94969; TRSR-68-030) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The organic constituents inventory for materials of earth origin deposited on the Moon in the course of lunar exploration is summarized in this report: (1) determination of microbial exposure probabilities; (2) feasibility of estimating microbial loads by fracturing sample materials; and (3) potential effects of recent findings on spacecraft sterilization requirements. The latter work entailed the study of spacecraft equipment fracturing and associated microbial release probabilities. Author

N68-26014 Michigan Univ., Ann Arbor.
VELOCITY FIELDS IN SUNSPOTS, THE EVERSHED EFFECT
Stephen Miller Adler 1966 148 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8202

The motion of material within sunspots was investigated. The study, directed primarily at the penumbrae of the spots, makes use of spectra taken at the McMath–Hulbert Observatory. Four spots were studied in detail, using photometric sections (line profiles) constructed with the isophotometer at the McMath–Hulbert Observatory. Asymmetries, which are presumably caused by a motion of material in the spots, were seen in the penumbral profiles. A correction for the limb effect, which is the apparent shift of a solar line toward the red as the limb of the sun is approached, was also considered. The reduction procedure, which assumes that the velocity field is radially symmetric about the center of the spot, allows the determination of both the direction of flow and its magnitude. Dissert. Abstr.

N68-26107*# California Univ., Los Angeles. Dept. of Engineering.
SOME RECENT RESULTS IN AEROSPACE VEHICLE TRAJECTORY OPTIMIZATION TECHNIQUES
Edward J. Bauman (AF Acad., Colo. Springs), C. T. Leondes, R. A. Niemann (Los Angeles State Coll.), and Garrett Paine (JPL) 1967 55 p refs Presented at the 18th Intern. Astronautics Federation Congr., Belgrade, Sep. 1967
(Grants NSG-237-62; AF-AFOSR-669-67)
(NASA-CR-88301) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The use of algorithms for solving trajectory optimization problems is discussed, and four computation techniques are described. (1) A quasilinearization method is presented, and it is shown how bounds may be placed on continuous controls directly in the method without additional variables. The minimum heating entry problem is solved for both bounded and unbounded control. (2) A multilevel technique is applied to optimize interacting

trajectories (subarcs) that may contain discontinuities in the state, the state derivatives, and/or the cost function at the subarc interfaces. Each subarc is optimized independently, and a second-level controller is used to adjust the interface conditions to achieve an optimal trajectory. The advantage of using different optimization techniques on the different subarcs is considered to offset the disadvantage of repeated subarc optimizations. (3) To solve the variable time problem, computational algorithms are developed to vary the first time so that the Hamiltonian is driven to zero. (4) Algorithms are also derived for variable end point problems in which the terminal vector is merely constrained to lie in some (n-k)-dimensional manifold of the n-dimensional Euclidean space M.G.J.

N68-26122 California Univ., Davis.
EDDY TRANSPORT MAINTENANCE OF SOLAR DIFFERENTIAL ROTATION
George Herman Nickel 1966 62 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-8881

The differential rotation of the sun is interpreted as the largest axisymmetric mode of two-dimensional surface turbulence which is symmetric under reflection through the equatorial plane. The amplitude of this mode is determined by a balance of energy transport into the mode from smaller modes and energy dissipation by eddy viscosity. These smaller modes could be either photospheric turbulence or larger scale motions due to a horizontal instability which could arise if the solar equator were slightly warmer than the poles. Energy transport to large modes from small modes is a property of two-dimensional turbulence; an estimate is made for the maximum radial velocity of large scale motions in the convective zone for which the model is valid. A computer model of the nonlinear interaction of these two-dimensional modes verifies that energy can be transported to the differential rotation mode, and that the correlation of zonal and meridional velocities is in qualitative agreement with results obtained from sunspot observations. Author

N68-26153*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE APPLICATION OF SPACE SHIELDING TECHNOLOGY TO SPACECRAFT PROBLEMS
Russel D. Shelton *In its* Protect. against Space Radiation 1968 p 611-631 refs (See N68-26128 15-29)

Knowledge about radiation environments and applications of radiation transport techniques are discussed in relation to the solution of several spacecraft radiation shielding problems. Particle threshold detection and anisotropic detectors for determining directional distribution of electron radiation are considered; as are damage to solar cells, use of space insulators, film fogging, charge transport by neutral radiation, and proton shield evaluation. M.W.R.

N68-26245*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN ANALYSIS OF THE LUNAR GRAVITATIONAL FIELD AS OBTAINED FROM LUNAR ORBITER TRACKING DATA
Robert H. Tolson and John P. Gapcynski [1967] 27 p refs Presented at the IQSY/COSPAR Assemblies, London, 17-28 Jul. 1967
(NASA-TM-X-60250) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A set of coefficients defining the lunar gravitational field has been determined from analysis of the tracking data from the Lunar Orbiter series, primarily Lunar Orbiters I, III, and IV. The gravity potential is represented by the usual series of spherical harmonics, and a set of coefficients through degree and order five is presented. Because the data are obtained from satellites having limited distribution of orbital geometries, high correlations exist between certain pairs of gravity coefficients. However, the gravity set is shown to be dynamically consistent in that the state of the satellites can be predicted over periods of time which extend beyond the tracking data arcs used to obtain the coefficients. The resulting gravity set is compared with a smaller set obtained from Luna 10 and the agreement is good. The lunar gravitational constant is also determined and the result compares favorably with recently determined values from other space missions. Author

N68-26295# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
DIGITAL ATTITUDE SIMULATION IMPUTTOR DICTIONARY, APPENDIX TO TG-964
P. P. Pardoe Feb. 1968 115 p
(Contract NOw-62-0604-c)
(TG-964A; AD-668140)

This appendix lists the names for and gives the definitions of the terms mentioned in report TG-964. TAB

N68-26328*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
THE GEOMAGNETIC TAIL: TOPOLOGY, RECONNECTION AND INTERACTION WITH THE MOON
C. P. Sonett, D. S. Colburn, R. G. Currie, and J. D. Mihalov [1967] 52 p refs Presented at the Summer Inst., Phys. of the Magnetosphere, Boston Coll., Chestnut Hill, Mass., 26 Jun. 1967
(NASA-TM-X-60238) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The geometry of the geomagnetic tail is assessed using data from the Ames magnetometer on the Explorer 33 satellite. The general shape corresponds to the earlier findings of Ness and co-workers. The tail is found regular to distances greater than 82 R_e. The field values vary for $K_p \leq 2+$ from a low of about 4 gamma to a high value of 40 gamma. Generally the values are near 10 to 20 gamma. A distinct skewing of the field lines away from the solar-antisolar direction is observed, such that an added component of magnetic field in the direction of planetary motion is present on both sides of the null plane. The skewing appears to be greatest near the null plane. Increase in field magnitude with increasing K_p is observed. The radial gradient can be shown to fit a power or exponential law with near equal validity. A correlation analysis of field magnitude with radial distance, a_p, and transverse position corrdinates is also discussed. Little cross gradient is observed in the tail field. Strong evidence for reconnection of field lines is found, and statistics are presented for a dual effect regarding the residual Z field across the null plane. Interaction of the tail field with the moon is discussed in terms of the mechanism of Sonett and Colburn. Author

N68-26394 Stanford Univ., Calif.
MINIMUM-FUEL TRANSFERS BETWEEN COAXIAL ORBITS BOTH COPLANAR AND NONCOPLANAR
Colman Byron Winn (Ph.D. Thesis) 1967 108 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7985

The problem considered in this report is that of minimum-fuel transfer between coaxial orbits, both coplanar and nonplanar. There is no constraint placed on the time taken to achieve a transfer. A variation of parameters formulation in connection with the calculus of variations and the Pontryagin Maximum Principle has been employed to obtain a complete solution to this problem. It was found that the optimal strategy is to apply impulses, and the number and method of applying the impulses was determined. It was determined that three-impulse noncoplanar transfers are sometimes optimal, but never are more than three impulses to be used. Dissert. Abstr.

N68-26587# Air Force Cambridge Research Labs., Bedford, Mass.
SPECTROPHOTOMETRIC STANDARDS FOR THE 1962 TOTAL SOLAR ECLIPSE
F. Q. Orrall Feb. 1968 35 p refs *Its* Instrumentation Papers, No. 139
(AFCRL-68-0057; AD-668091)

This report contains the information needed to make spectrophotometric measurements on the numerous jumping-film spectrograms obtained at the total solar eclipse of 4 and 5 February 1962 at Lae, New Guinea, by a joint expedition of the High Altitude Observatory, the National Bureau of Standards, and the Sacramento Peak Observatory (AFCRL). It includes a brief description of the instrument, a catalog describing each of the spectrograms, characteristic curves for the photographic emulsions used, and a procedure for reducing photometric measurements to absolute intensity. Author (TAB)

N68-26604*# Harvard Coll. Observatory, Cambridge, Mass.
MULTICOLOR PHOTOELECTRIC PHOTOMETRY OF THE MOON, VENUS, MARS, AND OTHER PLANETS Final Report, 15 Jun. 1960–31 Jan. 1968
Donald H. Menzel and William M. Irvine 29 Feb. 1968 89 p refs
(Grant NsG-89-60)
(NASA-CR-94803) CSCL 03A

This project was undertaken to provide basic data on the variations of luminosity of the main planets as a function of phase angle and wavelength. The lack of basic empirical data had in the past greatly hindered theoretical studies of planetary atmospheres; in particular, the integral albedo governing the heat balance of the atmosphere remained uncertain and the interpretation of the phase curves through models of the planetary atmospheres was practically impossible. The results obtained have in large measure filled this gap in empirical data. In addition, important new results were obtained concerning instrumentation for photoelectric photometry. Finally, significant advances have been made in the application of radiative transfer theory to planetary atmospheres. Author

N68-26623# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
A DESCRIPTION OF THE DIGITAL ATTITUDE SIMULATION
P. P. Pardoe Feb. 1968 130 p refs
(Contract NOw-62-0604-c)
(TG-964; AD-668141)

The Digital Attitude Simulation (DAS) described deals with the trajectory and attitude motion of an earth-orbiting spacecraft of very general configuration. The spacecraft may have a mass distribution as a function of time and one generalized coordinate. The equations of motion are derived using Lagrangian mechanics. Perturbations owing to the higher order terms of the earths potential, radiation pressure, and earths magnetic field are described. The program can simulate the action of spin, gravity-gradient, or magnetically stabilized spacecraft. Options for using rotors, gravity-gradient booms, and a large variety of damping schemes including hysteresis, eddy current, time-lag, ball-in-ball, gimballed boom, and viscous dampers are available. Author (TAB)

N68-26642*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON SOME POSSIBLE SIMPLIFICATIONS AND CHANGES IN HANSEN'S LUNAR THEORY
Peter Musen Washington Jun 1968 28 p refs
(NASA-TN-D-4562) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Several devices which permit us to reduce the number of quantities which must be re-computed with each iteration cycle are introduced. We refer the motion of the satellite to an almost ideal system of coordinates with two axes lying in the mean orbital plane. The position of the satellite relative to the almost ideal system is determined by Hansen's coordinates $1 + \nu$ and $N_0 \delta z$ of the projection of the satellite on its mean orbital plane and by the "elevation" ζ of the satellite relative to this plane. The position of the almost ideal system itself with respect to an inertial system is determined by two uniform rotations, one around the normal to the orbital plane of the sun, and one around the normal to the mean orbital plane of the satellite. The problem of integration is reduced to solving a linear partial differential equation by means of successive approximation, or to expanding the integrating operator into a series of products of two linear operators. One of these operators is a linear partial differential operator and the other is the inverse of a linear partial differential operator with the constant coefficients. We propose here, as in the previous work, to compute Hansen elements ξ, T and Ψ separately and to fuse them into W bypassing Hansen's function W. Author

N68-26643*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ON THE APPLICATION OF LIE-SERIES TO THE PROBLEMS OF CELESTIAL MECHANICS
Karl Stumpff Washington Jun. 1968 29 p refs
(NASA-TN-D-4460) CFSTI: HC $3.00/MF $0.65 CSCL 03C

Since Newton, the stumbling block in celestial mechanics has been the three-body problem. Only restricted cases have yielded solutions. This paper describes a device, the "Lie-Series," that first appeared in Lie's work on analytical transformations; Gröbner has shown that they can be used to solve systems of differential equations by applying differential operators to known functions or to invert systems of analytical functions. The series are applied to Kepler's problem of an undisturbed planet round the sun (two-body problem), to the study of perturbations, and to the process of obtaining the characteristics for any general dynamical problem. Author

N68-26689*# Northrop Corp., Hawthorne, Calif.
GENETIC STATES OF SIMULATED LUNAR ROCKS
Emanuel Azmon Washington NASA Jun. 1968 152 p refs
(Contract NAS7-358)
(NASA-CR-1081; NCL-67-44R) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Concepts leading to beneficial uses of rocks on the moon were developed. Most of the raw materials used are commonly and abundantly available silicate rocks. It is hoped that similar silicates will be found to be common and abundant on the lunar surface. The concept developed in this study is that of a genetic state which is the state from which a rock of distinct characteristics is born. This state is a function of the pressure and temperature conditions that a rock material is exposed to, as well as of the history (time and rate of changes) of pressures and temperature. Specific genetic states of several rocks are shown as genetic diagrams in this report. Most of the phases that are shown in the diagrams to coexist are not in equilibrium with their system, but were "frozen" into existence by quenching prior to attainment of equilibrium. Author

N68-26702*# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
THE INTANGIBLES OF HABITABILITY DURING LONG DURATION SPACE MISSIONS
T. M. Fraser Washington NASA Jun. 1968 83 p refs
(Contract NASr-115)
(NASA-CR-1084) CFSTI: HC $3.00/MF $0.65 CSCL 05E

The nature and meaning of habitability are discussed in relation to the requirements for long duration manned space missions. Several models of habitability are examined, and it is suggested that habitability can be considered as that equilibrium state, resulting from man-machine-environment-mission interactions which permits man to maintain physiological homeostasis, adequate

performance, and psycho-social integrity. The attributes of habitability are examined, and indices of habitability are discussed. No attempt is made to examine all the requirements for optimum habitability, an exercise which would involve consideration of every aspect of the interactions occurring in the entire man-machine-environment-mission complex. Attention if focussed instead on some of the less common aspects, and a discussion ensues on requirements for free internal volume, configuration, privacy (territoriality), personal hygiene, illumination, decor, color, recreation, and the use of leisure time, during a long duration manned space mission. Author

N68-26740*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
GRAVITY GRADIENT MOMENTUM DUMPING AND DYNAMICS ANALYSIS
Dale Ingwerson 5 Sep. 1967 254 p refs
(Contract NAS8-21003)
(NASA-CE-61815; LMSC-A842319) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Several control loops and control laws are assessed for dumping control moment gyros (CMG) momentum by gravitational torques. Gravity gradient momentum dumping laws are derived, based on the assumption that the vehicle can follow four consecutive step commands with zero error. Simulation results for the experiment point system (EPS) are summarized. As vibration of the AAP cluster introduces serious limitations on the speed of response obtainable, vibration stability analyses were conducted on the z-axis control and x--y axis control. A mathematical model of the flexible Apollo telescope mount (ATM) cluster is derived, based on the assumption that the cluster is a network of interconnected rigid bodies subjected to continuous rotational deflections about these interconnections. The total ATM simulator, to be used in evaluating and optimizing man's operation in the total integrated ATM control system and onboard experiments, is described. M.G.J.

N68-26741*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
CLUSTER A MISSION STUDIES
5 Sep. 1967 120 p refs
(Contract NAS8-21003)
(NASA-CR-61816; LMSC-A842318) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Ground rules and assumptions are listed for a 56-day mission to be launched in mid-1969 with the objectives of making intensive observations of the sun with a manned observatory in space, and measuring the effects on men and vehicles of prolonged periods in space. Attitude stabilization methods are considered in relation to the requirement that the solar panels must be pointed at the sun during the AAP-1, AAP-2 (and possibly AAP-3A) missions. Vehicle characteristics and the analytical representation used (coordinate system, equations, etc.) are defined, and the uncontrolled motion and the control impulse requirements for various conditions are developed. Analyses were also performed to determine the power available from the AAP solar array system mounted on the S-4B. Initial studies were made with 6 arrays having 63 panels and 2 arrays having 44 panels. Results were obtained for the solar arrays in the sun-oriented mode as well as for the arrays in various locations in the gravity-gradient (storage) mode. M.G.J.

N68-26812*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
ATM MISSION OPERATIONS DOCUMENTATION
5 Sep. 1967 53 p
(Contract NAS8-21003)
(NASA-CR-61817; LMSC-A842330) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This plan defines the application of the ground based solar monitoring facility and experiment support personnel during solar ATM operations. Coordination of these ground based activities within the constraints established by centralized mission control are discussed along with a description of the type of data available to support real time decisions and postflight analysis. A centralized data collection agency will be established at the Huntsville Operations Support Center for limited quick look data evaluation during the mission. This will also be the repository for all mission data used for postflight analysis and dissemination to the scientific community. Author

N68-26836# Observatorio del Ebro, Tortosa (Spain).
IDEAS ON THE ACTUAL STATE OF COSMOLOGY [IDEA SOBRE EL ESTADO ACTUAL DE LA COSMOLOGIA]
A. Romana 1966 29 p refs In SPANISH
(Memo-12) CFSTI: HC $3.00/MF $0.65

An overview is presented on the gradual development of ideas on the formation of the universe, and various cosmological theories that explain astronomical phenomena are assessed. Both classical and new viewpoints are discussed, and a number of models of the universe are considered. The theological implications of some cosmological theories are examined, and a reference bibliography is included. Transl. by F.S.

N68-26837* Naval Research Lab., Washington, D. C. E. O. Hulburt Center for Space Research.
PARTICLES OF UNKNOWN ORIGIN PHOTOGRAPHED AT ROCKET ALTITUDES
R. Tousey and M. J. Koomen [1967] 12 p refs Presented at the Intern. Symp. on the Zodiacal Light and the Interplanet. Medium, Honolulu, Hawaii, 30 Jan.–2 Feb. 1967
(NASA Order R-09-029-036)
(NASA-CR-85622) CSCL 03A

Photographs of the solar corona from R = 3.5 to 11 R_S, made from Aerobee–150 rockets with externally occulted Lyot coronagraphs, show tracks of particles in the altitude range 120 to 204 km. By its nature the experiment selects only those particles that are traveling with approximately the instantaneous velocity of the rocket, since all others cross the field too fast to expose a perceptible trail. On the flight of June 28, 1963 more than thirty-five particles were recorded, at distances ranging at least to 500 meters. Their diameters lay in the range 10–30 μ. On April 28, 1966 two coronagraphs were flown side by side, making identical and simultaneous exposures. Many more particles were recorded than on the first flight. The experiment was repeated on November 12, 1966 and this time many fewer particles were recorded. Author

N68-26840# Technische Univ., Berlin (West Germany). Inst. fuer Raumfahrttechnik.
NECESSITY FOR FAST AND ECONOMIC INTERPLANETARY SPACE FLIGHT SYSTEMS [UEBER DIE NOTWENDIGKEIT SCHNELLER UND WIRTSCHAFTLICHER INTERPLANETARER RAUMFAHRT-SYSTEME]
Guenter W. Tumm 4 Oct. 1966 39 p refs In GERMAN Presented at DGRR/WGLR Ann. Meeting, Bad Godesberg, Oct. 1966
(TUB-IR-4/1966; Rept.-66-035) CFSTI: HC $3.00/MF $0.65

The technical and economic feasibility of fast interplanetary systems is discussed. Mission optimization is considered, taking into account mission flexibility, net growth payload, and cost effectiveness. The ORION, gas core, and NERVA 2 nuclear propulsion systems are evaluated. It is shown that for establishing manned planetary stations, the use of the ORION or the gas core propulsion system is advantageous from the standpoint of human, technical, and economic resources. K.W.

N68-26945# Joint Publications Research Service, Washington, D. C.
SOVIET SPACE PROGRESS REVIEWED

13 Jun. 1968 18 p Transl. into ENGLISH from Izv. (Moscow), 13 Apr. 1968 p 1–2
(JPRS-45658) CFSTI: HC $3.00/MF $0.65

Speeches presented on Cosmonautics Day, April 13, 1968 deal with Soviet space accomplishments and the efforts of the Communist party and workers. A general review of scientific satellites and other space vehicles is included in these speeches. M.W.R.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N68-25732*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LUNAR EXPLORER 35
Norman F. Ness May 1968 55 p refs Presented at 11th COSPAR, Tokyo, 16 May 1968
(NASA-TM-X-63225; X-616-68-166) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Lunar Explorer 35 experiment repertoire includes magnetometers, plasma probes, energetic particle and cosmic dust detectors. Bi-static radar measurements of the electromagnetic properties of the lunar surface have been studied by monitoring the transmitted and reflected RF signal. Results show that the moon is immersed in either interplanetary space or the geomagnetosheath-geomagnetotail formed by the solar wind interaction with the earth. In the geomagnetotail no evidence is found for a lunar magnetic field limiting the magnetic moment to 10^{20} cgs units. In the interplanetary medium no evidence is found for a bow shock wave due to supersonic solar wind flow. The moon does not accrete interplanetary magnetic field lines. A plasma shadow or cavity develops on the anti-solar side of the moon. Small magnetic field perturbations consist of penumbral increases and decreases but only umbral increases are observed due to the diamagnetic properties of the plasma. Diffusion of interplanetary field lines through the lunar body indicates a low electrical conductivity for the outer layers of the moon, less than 10^{-5} mhos/m., and correspondingly low body temperatures. Author

N68-25820*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE FABRICATION AND TESTING OF PAGEOS 1
Louis A. Teichman Washington, D. C. Jun. 1968 55 p refs
(NASA-TN-D-4596) CFSTI: HC $3.00/MF $0.65 CSCL 22B

As an aid in assuring the successful construction and deployment of PAGEOS I, detailed fabrication process specifications were prepared and an extensive testing program was conducted. This large body of information on fabrication processes, testing techniques, and material properties is summarized herein as an indication of the present state of the art of inflatable sphere technology. Author

N68-25848*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SATURN IB SA-217 REFERENCE LAUNCH VEHICLE
16 Jan. 1968 66 p refs Supersedes R-P&VE-DIR-65-92
(NASA-TM-X-53686) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A definition of a reference Saturn IB launch vehicle designated SA-217 is given. The Saturn IB SA-217 is a projected reference vehicle, based on Saturn IB SA-212, incorporating the latest proposed product improvements. The two-stage payload capability of this vehicle to a 100-nautical-mile circular orbit is 44,985 pounds. The Saturn IB SA-217 launch vehicle is to be used as the baseline vehicle for advanced studies requiring the use of the standard or modified Saturn IB launch vehicle. This vehicle definition does not necessarily represent approved changes to any specific vehicle. Author

N68-25849# Giravions Dorand Co., Paris (France).
SPACE ROTOR: EUROPEAN PROJECT FOR RECOVERY OF HEAVY LAUNCH VEHICLES
M. Kretz 1966 27 p refs Presented at the 6th European Symp. on Space Technol., Brighton, England, 23–25 May 1966
CFSTI: HC $3.00/MF $0.65

The difficulties faced in reentry and recovery problems of the satellites and launcher vehicles are defined as (1) protection of the vehicle against the intense heat flux and heavy load factors, (2) control, reentry maneuverability, and aerodynamic stability during hypersonic flight, and (3) the landing of a fragile structure without damage. Using the ELDO as an example, the results of an experimental study are presented in which rotary wings are applied to recovery of heavy launchers. The advantages of the space rotor are listed, and the features which render its performance satisfactory are discussed. B.S.D.

N68-25874*# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ORBITAL EXTRAVEHICULAR MOCKUP DESIGN
Paul Iribe Jan. 1968 28 p
(NASA Order R-21-009-009; Contract NOw-62-0604-c)
(NASA-CR-94927; TG-957) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Extravehicular activities in space such as inspecting orbiting spacecraft, servicing orbiting equipment, performing assembly tasks in space, and making space rescues will require an extravehicular work platform. The proposed one-man extravehicular work platform is an example of extreme man-machine integration. A study of the requirements for extravehicular protection and operation for such activities led to the immediate construction of a full-scale mockup of the required type of platform in order that it might serve as a focus for discussion, give a first look at the engineering feasibility of the platform, arbitrarily reduce the number and variety of contending designs, and be useful in future studies. The principal design features of this full-scale mockup are described. Of the contending designs, the one chosen for the mockup was a modularized "backpack" equipped with a propulsion capability, a backup for a portable life support system, a communication subsystem for voice and telemetry, a TV monitoring subsystem, a rechargeable electrical power source, and pack-mounted illumination and mechanical manipulators. The basic design can be augmented by special modules to meet the requirements of particular missions. Author

N68-25934*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APPLICATIONS TECHNOLOGY SATELLITE, VOLUMES 1 THROUGH 6 Technical Data Report
6 Jun. 1968 4159 p Revised Supersedes NASA-TM-X-60437; See N67-86371
(NASA-TM-X-61130; NASA-TM-X-60437) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Design, development, fabrication, prelaunch test, and flight performance data are presented on the Applications Technology Satellite program, which was undertaken to collect and confirm data for various technologies having wide applications in space and space flight. Among the major experiments are those concerned with the stabilization of satellites by gravity gradient techniques. The multiple-mission design concept allows for numerous different space and earth studies, plus experimentation with advanced satellite communication technologies. Systems analyses are presented on

the spacecraft and launch vehicles; operations and orbit parameters are defined for the five ATS flights; and ground station equipment and support are described. Details are given on the designs for the communications, meteorological, gravity gradient and environmental measurements experiments, and on other technological experiments pertaining to the nutation sensor, the self-contained navigation system, and albedo and ionospheric studies. Performance data for each are analyzed. M.G.J.

N68-26004# Technische Univ., Berlin (West Germany).
ASSESSMENT OF MAXIMAL TRANSPORT CAPACITY AND COMPARATIVE ANALYSIS OF ONE-WAY TRANSPORT SYSTEMS TO THE MOON AND MARS [ABSCHAETZUNG DER MAXIMALEN TRANSPORTKAPAZITAET UND VERGLEICHENDE ANALYSE VON EINWEGTRANSPORT SYSTEMEN ZUM MOND UND MARS]
Juergen Bommer (Ph.D. Thesis) [1967] 182 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Capacity examples and representative alternatives are given of space transportation systems, taking into account vehicle size and all technical and economical aspects of mission planning. Attainment of a given transport capability within a given time is considered in the light of availability of engineering manpower. Limitations of the space transportation capability are estimated based on requirements of structural materials and propellants projected against present and future production volumes. A theoretical approximation of maximum transport capacity results in a total of $15 \cdot 10^6$ passengers with equipment for five years within a period of 25 years following the start of a program. Transl. by K.W.

N68-26022*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
CONTROL AND DISPLAY PANEL DESIGN Research Report, 8 Jul.–6 Sep. 1967
Z. V. Adams, M. L. Blackledge, A. M. Ellison, G. O. Floyd, J. H. Lane et al 5 Sep. 1967 66 p refs
(Contract NAS8-21003)
(NASA-CR-61814; LMSC/HREC-A784656) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Drawings, specifications, interface control documentation, and parts lists for the Apollo telescope mount (ATM) control and display (C & D) console design were revised and updated. Panel and console configurations are depicted, and criteria used in optimizing the allocation of the C & D panels and components are defined. Structural and thermal analyses data are summarized, and the major electrical design work is outlined. Two command address systems were compared for function and reliability, and a combined system which uses the best features of each is recommended. M.G.J.

N68-26026 Bolkow Entwicklungen K. G., Munich (West Germany).
THE ENVIRONMENTAL TESTING OF THE THIRD STAGE OF THE EUROPEAN SUPPORT ROCKETS [DIE UMWELTERPOBUNG DER 3. STUFE DER EUROPAEISCHEN TRAEGERRAKETE]
Heinz Goehre 16 Sep. 1966 34 p In GERMAN Presented at 2d Joint Ann. Meeting of the DGRR/WGLR, Bad Godesberg, West Ger., 4–8 Oct. 1966
(EV-60-O) CFSTI: $3.00

Depicted are methods and instrumentation for environmental and quality control testing during the development of the third stage for the European Spacecraft (ELDO). Inclosed are graphical illustrations of high pressure vessels for helium burst tests, vibration tests, and temperature tests. Transl. by G.G.

N68-26240# National Academy of Sciences—National Research Council, Washington, D. C. World Data Center A.
CATALOGUE OF DATA IN WORLD DATA CENTER A: ROCKETS AND SATELLITES, 1 JANUARY 1966–31 DECEMBER 1967
Mar. 1968 97 p refs

A complete listing of all data received by World Data Center A for Rockets and Satellites is presented. Data is reported for the period January 1, 1966 through December 31, 1967. An author index is included grouped according to various participating countries. B.S.D.

N68-26807# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BALLISTICS OF LONG-RANGE GUIDED ROCKETS
R. F. Appazov, S. S. Lavrov, and V. P. Mishin 26 Sep. 1967 223 p refs Transl. into ENGLISH of the book "Ballistika Upravlyayemykh Raket Dal'nego Deystviya" Moscow, Izd. Nauka, 1966 p 1–307
(FTD-MT-24-177-67; AD-668095)

This book serves as an introduction to the study of the ballistics of long-range missiles. It discusses flight theory and methods of calculating trajectories. Contents: General theory of motion; Ballistic calculations of controlled long-range rockets; Dispersion with firing by long-range rockets; and Selecting the form of the trajectory. TAB

N68-26645*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANALYTICAL INVESTIGATION OF EFFECTS OF PHYSICAL AND AERODYNAMIC PARAMETERS ON DYNAMIC BEHAVIOR OF PROJECT FIRE REENTRY VEHICLE
Jacob H. Lichtenstein Washington Jun. 1968 57 p refs
(NASA-TM-X-1589) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The heat-transfer characteristics of a body entering the earth's atmosphere at superorbital velocities are important in the consideration of any planetary mission. In an attempt to measure these characteristics experimentally, Project Fire was undertaken. During the design phase of the reentry vehicle, information was necessary as to whether certain physical and aerodynamic parameters would become important design considerations. Consequently, an analytical study was undertaken to evaluate the effects of these parameters on the dynamic behavior of the reentry vehicle. The results of the investigation showed that changes in most of the parameters considered, for instance, ±21 percent in the moments of inertia and ±50 percent in the spin rate, would not affect the dynamic behavior during the main heat-measuring period (the first 40 seconds) enough to cause serious design problems. However, mass-distribution asymmetry that would displace the center of gravity 1/8 inch (0.003 meter) or more from the vehicle axis of symmetry would create angle-of-attack disturbances large enough to be significant. Author

N68-26726# Aerospace Corp., El Segundo, Calif. Technical Operations.
FUTURE NEEDS AND TRADEOFFS FOR LONG-LIFE SPACECRAFT
R. W. Slocum, E. I. Roberts, and R. J. Smith Jan. 1968 42 p
(Contract F04695-67-C-0158)
(TR-0158(3525-15)-1; SAMSO-TR-68-101; AD-668076)

Three basic areas related to long-life military spacecraft are examined. First, the background for such spacecraft is described, and representative satellite designs are utilized to demonstrate the economic savings achievable. Second, as an example of the application of reliability specifications to an actual program, the history and development of these specifications in the Initial Defense Communications Satellite Program (IDCSP) are presented. Reliability and quality assurance aspects of proposed programs are

then examined from the standpoint of ensuring that specifications will be met. Specific techniques are not considered for achieving long spacecraft life in the various mission areas. Author (TAB)

N68-26814*# Boeing Co., Seattle, Wash.
LUNAR ORBITER 4: PHOTOGRAPHIC MISSION SUMMARY, VOLUME 1
Washington NASA Jun. 1968 126 p
(NASA-CR-1054; D2-100754-1, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The objectives, launch preparation, and operations of the Lunar Orbiter 4 mission are described. The primary objective was to perform a broad systematic photographic survey of lunar surface features to serve as a basis for selecting sites for more detailed scientific study by subsequent orbital and landing missions. All mission objectives were accomplished. Some of the more significant accomplishments of the mission included: (1) the first photographic mapping mission of a celestial body, other than earth, from an orbiting spacecraft; (2) photographic coverage (over 99%) of nearside of the moon of resolutions at least 10 times better than Earth-based observations; (3) the first detailed near vertical photos of the geologic formations of the Orientale basin at the western limb; and (5) photo data by which photo sites for the Lunar Orbiter 5 mission were relocated to optimize and maximize the scientific data requirements. A.L.

N68-26927# Hawker Siddeley Dynamics, Ltd., Stevenage (England). Space Projects Div.
THE ESRO 2 SATELLITE PROJECT
C. R. Hume 31 Mar. 1966 40 p refs Presented at the 6th European Symp. on Space Technol., Brighton, Engl., May 1966
CFSTI: $3.00

A general technical description is presented on the ESRO 2 satellite, which was scheduled to carry an integrated payload involving experiments from different countries. The objectives of each experiment are outlined. Consideration is given to several aspects of the project management which involved close cooperation and considerable liaison between various nationalities. Also discussed are the communication methods developed to handle these special problems. M.G.J.

N68-26950# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.
INVESTIGATION OF PROGRAM EFFICIENCY OF VARIOUS PROJECT COMBINATIONS AS AN ALTERNATIVE TO THE ELDO PROGRAM [UNTERSUCHUNG UEBER DIE PROGRAMMWIRKSAMKEIT VERSCHIEDENER PROJEKT-KOMBINATIONEN ALS ALTERNATIVLOESUNGEN FUER DAS ELDO PROGRAMM]
H. H. Koelle 15 Oct. 1966 93 p In GERMAN
(TUB-IR-5/1966) CFSTI: HC $3.00/MF $0.65

Studied is the problem of long-term planning of space missions from the German point of view, using modern concepts and methods of operations research. A formal method is described which reduces erroneous decisions to a minimum and accelerates the process of decision making. Mission objectives and all factors affecting them are considered. Alternate objectives and priorities for projects are combined to form logical programs. Several typical alternatives are examined for cost effectiveness and other selective criteria. Transl. by K.W.

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N68-25660# New Mexico Univ., Albuquerque. Bureau of Engineering Research.
ON A NUMERICAL TECHNIQUE FOR ELASTIC WAVE PROPAGATION
Robert S. Pritchard and Frederick D. Ju Jan. 1968 45 p refs Prepared for Sandia Corp.
(Contract AT(29-1)-789)
(SC-CR-68-3501) CFSTI: HC $3.00/MF $0.65

A numerical technique is developed to analyze circumferentially symmetric impact of three-dimensional elastic regions. Velocities and displacements are determined, using single-level difference equations which are stable for a reasonable range of parameters. Solutions are presented for two problems in which step discontinuities are introduced initially into the velocity fields. Author (NSA)

N68-25683*# Harvard Univ., Cambridge, Mass.
POST-BUCKLING BEHAVIOR OF CYLINDERS IN TORSION
Bernard Budiansky Aug. 1967 32 p refs Presented at the 2d IUTAM Symp. on the Theory of Thin Shells, Copenhagen, 5-8 Sep. 1967
(Grant NsG-559)
(NASA-CR-88232; SM-17) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The initial post-buckling behavior and the consequent imperfection-sensitivity of thin-walled cylinders subjected to torsion are studied on the basis of the Kármán-Donnell equations. A perturbation analysis consistent with the general theory of the post-buckling behavior of structures leads to eighth-order systems of complex, ordinary differential equations that are solved numerically for several sets of boundary conditions. Author

N68-25693# California Univ., Livermore. Lawrence Radiation Lab.
COMPENDIUM OF SHOCK WAVE DATA
M. van Thiel, ed., A. S. Kusubov, ed., and A. C. Mitchell, ed. Oct. 1967 23 p refs
(Contract W-7405-ENG-48)
(UCRL-50108, V. 2, Sup. 1) CFSTI: HC $3.00/MF $0.65

New and corrected pages are given for inclusion in the original publication UCRL-50108. Thermodynamic data obtained by shock wave techniques are presented in graph and tabular form for hydrocarbons, organic compounds, and mixtures (organics, alloys, explosives, etc.). Material indexes are included. NSA

N68-25714*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A METHOD OF BENDING VIBRATION ANALYSIS FOR A VEHICLE WITH FLEXIBLY SUSPENDED COMPONENTS
Homer Pack 30 Apr. 1968 29 p refs
(NASA-TM-X-53733) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A method is developed for finding the natural modes and frequencies of a vehicle with flexibly suspended components. The vehicle is idealized as a system of one nonuniform beam and any number of flexibly suspended masses. A vibration analysis is first made of the beam, omitting the masses, by a modified Stodola method. The equations for the connected system are then derived using Lagrange's equations. Author

N68-25724*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
DYNAMIC STABILITY STUDY FOR SOUNDING ROCKETS Final Report
D. A. Price, Jr. and P. S. Woods Jan. 1968 78 p refs
(Contract NAS5-10438)
(NASA-CR-95054; LMSC-684879) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Investigated were the effects of joint rotation and compliance, body flexibility, fin flexibility, and induced and non-linear aerodynamic characteristics on roll resonance behavior of sounding

rockets. Maximum tolerance limits for center of gravity, aerodynamic trim and thrust misalignment with joint rotation and body bending (including joint compliance) are compared with those for a rigid vehicle for time variable linear aerodynamics. Application to the Aerobee 150 flight number 4.81 vehicle with twelve joints is made to demonstrate that joint rotation can provide a major source of roll lock-in. A computer program (FLEXCOR) for evaluating multiple-jointed body extensions which is applicable to sounding rockets in general is utilized. Induced and nonlinear aerodynamics are shown to cause reduction in asymmetry tolerances for a rigid body Aerobee 350 sounding rocket. Modifications to the existing Roll Pitch Motion program to accommodate induced and nonlinear aerodynamic characteristics in the dynamic motion and c.g. tolerance options are described. Author

N68-25727# Institute of Technology, Helsinki (Finland).
ON THE STIFFNESS OF NON-MONOLITHIC STRUCTURES
Herman N. Parland (Ph.D. Thesis) 1968 115 p refs *its* Publ. 123; *its* Dissertation No. 150
CFSTI: HC$3.00/MF$0.65

A study has been made of elastic structures with joints which do not transfer tensile stress, such as structures of prefabricated elements, but also pre-stressed, and reinforced concrete structures at the cracking stage. In such constructions, there exists in the joints and cracks no more than a partial continuity, which at increased loads reduces the rigidity, and may essentially change the distribution of moments and normal forces. The problems associated with this depend less upon the local stress distribution in the joints and more upon the stiffness properties of the structural elements which decide the distribution of the internal forces. The main emphasis has accordingly been laid upon the influence exercised by the stress and displacement discontinuities on the stiffness characteristics of the structure. Approximative methods of treatment of the discontinuities, and of pre-stress problems, call for modes of thought in which it is necessary to violate the fundamental axioms of classical continuum mechanics. For this reason, the present study begins with a brief, axiomatic presentation of the parts of continuum mechanics needed here, with particular reference to the special relations in the joints. Author

N68-25740# National Aeronautical Establishment, Ottawa (Ontario).
THE VIBRATION OF STEPPED CANTILEVERED PLATES
G. M. Lindberg Dec. 1967 52 p refs
(LR-494; NRC-10058) CFSTI: HC$3.00/MF$0.65

A theoretical and experimental study of seven stepped cantilevered plates is presented. Four of the plates are square, with increasingly severe steps, and the remaining three are non-rectangular, formed by removing parts of the outboard corners. The first nine natural frequencies and mode shapes of each of the plates are found experimentally and are compared with results predicted using two different approximate finite element representations. It is found that a relatively coarse gridwork of finite elements (4 elements × 4 elements) will predict frequencies with an accuracy of better than 5 percent and also accurately predict mode shapes. There appears to be little difference between the results predicted using the two different methods. The Energy models predict frequencies slightly closer to the experimental ones, but only the Hrennikoff model can be used to solve the non-rectangular problems. The present study serves to illustrate further the power of finite element techniques. Author

N68-25746*# California Univ., Berkeley.
ANALYSES OF SHELLS OF REVOLUTION BY FINITE ELEMENTS
E. P. Popov 1967 11 p refs Presented at the Intern. Congr. on the Appl. of Shell Struct. in Architecture, Mex. City, 3–7 Sep. 1967
(Grant NsG-274)
(NASA-CR-87648) CFSTI: HC$3.00/MF$0.65 CSCL 20K

A survey of the available methods of analysis for rotational shells using the finite element procedure is presented. The discussion is limited to the static analysis of shells such as are encountered in architectural and related applications. The versatility of the finite element procedure of stress analysis for shells of revolution of free form is demonstrated. Author

N68-25819*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TARGET PRESSURE AND DAMAGE DATA FROM IMPACTS BY EXPLOSIVELY PROPELLED PROJECTILES
A. B. Wenzel and Nestor Clough Washington, D. C. Jun. 1968 21 p refs
(NASA-TM-X-1597) CFSTI: HC$3.00/MF$0.65 CSCL 20K

Data on maximum shock-generated pressures at several axial positions in 1100-0 aluminum and on crater dimensions in 316-stainless steel were obtained from impacts by explosively-fired aluminum projectiles. The aluminum projectiles with mass ranging from 0.408 to 0.626 grams, impacted the targets at velocities of 11 km/sec. Comparisons of pressure data with similar data from light-gas gun impacts are included, together with a discussion of the "throw-off pellet" technique used to obtain axial pressures. Author

N68-25897 Missouri Univ., Rolla.
THE TRANSIENT DYNAMICS OF PLANE MECHANISMS
Navnit Chhaganlal Mehta (Ph.D. Thesis) 1967 121 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-9125

Accurate determination of dynamic characteristics of mechanisms has become more important with increased requirements on speed, efficiency and precision. Many devices, such as circuit breakers and computing mechanisms, operate under purely transient conditions and actuation time places a serious limitation on the response of the system of which these devices are a part. In the classical analysis, whether it be graphical or analytical, the mechanism is assigned a specified position and state of motion from which the forces required to produce the motion can be determined. The inverse problem of specifying the driving force and determining the resulting motion, which is much closer to the actual condition, is nearly impossible of solution with the classical approach. Dissert. Abstr.

N68-25898 Stanford Univ., Calif.
STRESSES IN CONICAL SHELLS
Wolf Altman (Ph.D. Thesis) 1967 102 p
Available from Univ. Microfilms: HC $5.20/MF $0.65 Order No. 67-7891

The fundamental equations and relationships are derived for a conical shell of constant wall thickness subjected to edge loads. The equations are combined so as to obtain a fourth order partial differential equation in complex form. The solutions are then found by using the Frobenius method. The solution for the axisymmetric case of edge loading is obtained in closed form. Part of this solution is given in terms of Thomson functions which is in turn identified with the classical solution for conical shells. This general solution is applied to the case of a finite conical shell with a concentrated load at the apex. For the case of a shallow conical shell with antimetric edge loading the solution is obtained in terms of Thomson functions of order two. As an application of this solution, the problem of a conical shell with a concentrated moment at the apex is considered. Dissert. Abstr.

N68-25899 Rochester Univ., N. Y.
THERMAL SHOCK IN THERMOELASTIC AND THERMO-VISCOELASTIC CYLINDERS AND SPHERES
Vincent James Piarulli 1967 125 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-8972

A class of thermal shock problems in a thermoelastic and thermoviscoelastic solid is studied using the mutually-coupled field equations of thermoelasticity and thermoviscoelasticity. A general procedure for developing solutions to the mutually-coupled field equations of thermoelasticity for particular boundary value problems is discussed; this discussion is kept very general by use of the Cartesian tensor formalism. The fully coupled field equations of thermoelasticity are written in cylindrical and spherical coordinates. These equations are further specialized to a single variable spatial dependence. The thermoelastic problems considered are thermal shock problems in cylinders and spheres wherein the time dependent temperature is prescribed on the boundaries. Dissert. Abstr.

N68-25900 Stanford Univ., Calif.
THE STABILITY OF BARREL-VAULT SHELLS
George Chih-ming Chiang (Ph.D. Thesis) 1967 72 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-7904

Investigations are made on the stability of an elastic cylinder of finite length, placed horizontally and simply supported at both ends. The load on the shell is assumed to be $p\cos(\pi x/l)$, which is considered to be a simulation of its weight. A set of three equations for the incremental displacement components is derived. These equations are linear, homogeneous partial differential equations with variable coefficients depending on both coordinates x and ϕ. The solution to the differential equations is assumed in the form of a double Fourier series. The coefficient determinant of a set of infinitely many algebraic equations is of infinite order. The convergence of this determinant is proved. Numerical work has been carried out on the Burroughs 5500 digital computer. The results show that the convergence of the infinite coefficient determinant is excellent for the example chosen. Additional numerical results are also obtained for the nondimensional critical load for a certain range of the shell's geometrical parameters. Dissert. Abstr.

N68-25923 Cornell Univ., Ithaca, N. Y.
THE FREE LATERAL VIBRATIONS OF A UNIFORM ANNULAR PLATE SUBJECTED TO AN INITIAL STATIC TORQUE
Conrad Ronald Kowal 1967 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-6425

The free lateral vibration of a thin annular plate of constant thickness subjected to an initial static torque uniformly distributed around the clamped inner and outer boundaries is investigated. Of primary interest is the effect of the prestress on the normal mode frequencies of the annular plate as the initial torque is increased to the torsional buckling value. A Frobenius series solution and an alternate closed form solution in terms of generalized hypergeometric functions are obtained for the governing equation of motion. It is found that the frequencies for the axisymmetric normal modes are not affected by the prestress; however, those of the nonaxisymmetric modes decrease as the initial torque is increased. The radial nodes for the non-axisymmetric modes are distorted into spiral patterns. The distortion progressively increases with increasing torque until the plate buckles in torsion. An experimental study is described and results are compared with theoretical frequency-load curves. The agreement is quite good and the theoretical predictions are largely verified until the specimen prematurely buckled. Dissert. Abstr.

N68-25925 IIT Research Inst., Chicago, Ill.
DYNAMIC RESPONSE OF CYLINDRICAL SHELLS
John Medige (Ph.D. Thesis) 1967 112 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8895

A general cylindrical shell theory is developed which accounts for transverse shear deformation and rotatory inertia, and which reduces to the well known Flügge theory upon their neglect. An exact, formal solution is presented for the dynamic response of a shell of finite length under arbitrarily distributed, arbitrarily time-dependent surface tractions, for arbitrary initial conditions and admissible (homogeneous) boundary conditions. A general orthogonality condition is established for solutions to the forced and free vibration problems under arbitrary surface tractions and end conditions. The formal solution is obtained in terms of eigenfunctions associated with the free vibration of the shell. Appropriate specific orthogonality and normalization conditions are formulated. The theory is applicable to moderately thick, as well as to thin shells. Dissert. Abstr.

N68-25992# Lockheed Missiles and Space Co., Palo Alto, Calif. Aerospace Sciences Lab.
INITIAL POSTBUCKLING BEHAVIOR OF STIFFENED CYLINDRICAL SHELLS
D. O. Brush Nov. 1967 53 p refs
(LMSC-6-77-67-52)

A theory for the initial postbuckling behavior of thin walled shells is applied in an analysis of the imperfection sensitivity of ring-and-stringer stiffened cylinders under axial compression. The cylinders are considered to be simply supported, and both eccentricity and torsional rigidity of stiffeners are taken into account. Values of an imperfection sensitivity parameter are determined for particular stiffened cylinders, and the suitability of the parameter as a practical measure of imperfection sensitivity is examined. Theoretical results are correlated with available data for the experimental buckling loads of stringer stiffened cylinders. Author

N68-25999# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
CALCULATION OF THE LOAD CARRYING CAPACITY OF INITIALLY SLIGHTLY IMPERFECT THIN WALLED CIRCULAR CYLINDRICAL SHELLS OF FINITE LENGTH
K. Y. Narasimhan and Nicholas J. Hoff Dec. 1967 106 p refs
(Contract AF 49(638)-1276)
(SUDAAR-329; AFOSR-68-0471; AD-668450)

The nonlinear partial differential equations of von Karman and Donnell governing the deformations of initially imperfect cylindrical shells are reduced to a consistent set of ordinary differential equations. A numerical procedure is then developed for the solution of these equations together with the associated boundary conditions. This method is used to determine the number of waves at buckling as well as the load carrying capacity of imperfect cylindrical shells of finite length subjected to uniform axial compression in the presence of the least amount of restraint along the simply supported boundaries. It is found that details of the boundary conditions have little effect on the number of waves into which the shell buckles around the circumference. This number is determined essentially by the length-to-radius and radius-to-thickness ratios. The absence of an edge restraint to circumferential displacements reduces the classical value of the buckling load by a factor of about two as compared to the classical value. On the other hand, shells with these boundary conditions are less sensitive to initial imperfections in the shape, and thus the maximal load supported in the presence of unavoidable initial deviations can be the same for shells with and without a restraint to circumferential displacements along the edges. Author (TAB)

N68-26011 Rochester Univ., N. Y.
SOME PROBLEMS IN DYNAMIC ELASTICITY
Mukund Digambar Gangal (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8952

The Rayleigh–Lamb and Pochhammer–Chree dispersion relations describing the propagation of elastic waves in infinite plates and infinite cylindrical rods respectively yield infinitely many solutions (modes) for the wave-numbers, real and imaginary, corresponding to a given frequency. In considering the reflection of a normally incident mode from a free edge, one must satisfy traction-free boundary conditions at the edge. The reflection of a mode is obtained as a combination of that mode and all the faster modes, by an expansion in powers of ϵ where ϵ is plate thickness divided by wave length. The traction free edge boundary conditions are expanded into a Fourier series of the characteristic functions, *i.e.*, hyperbolic for plates and Bessel for cylindrical rods. Truncation of the Fourier series at any given harmonic yields equations that overdetermine the coefficients. Dissert. Abstr.

N68-26071# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.
A REPORT ON THE CONSTRUCTIVE DESIGN AND ON THE WEIGHT ESTIMATION OF THE SKIN STRUCTURE OF BEITRAG ZUR KONSTRUKTIVEN GESTALTUNG UND ZUR SPACE TRANSPORTATION SYSTEM, NEPTUN [EIN BEITRAG ZUR KONSTRUKTIVEN GESTALTUNG UND ZUR GEWICHTSABSCHAETZUNG DER HAUTSTRUKTUR AN DER PILZDUESE DER ZWEITEN STUFE DES TRAEGER-SYSTEMS NEPTUN]
J. Allesch 1 Mar. 1968 56 p refs In GERMAN; ENGLISH summary
(TUB-IR-3/1968) CFSTI: HC $3.00/MF $0.65

A mass estimate was performed for plug-nozzle skin and skin structure of the large reusable space transportation system NEPTUN. Because NEPTUN has the concept of controlled simplicity the construction is not very complex: basically it consists of a skin connected to a system of frameworks. For the design a computer program was written which allows the input of all essential loads and structure materials. The optimal system was determined considering costs, weight, and different booster sizes. Author

N68-26113# Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands).
COMPARATIVE MECHANICAL TESTING OF SIX CORE MATERIALS IN SANDWICH STRUCTURES [VERGELIJKEND MECHANISCH ONDERZOEK VAN ZES KERNAMATERIALEN IN SANDWICHCONSTRUCTIES]
19 Feb. 1968 24 p refs In DUTCH
(TDCK-50343.2; Rept.-18/68) CFSTI: $3.00

Six different core materials were tested in identical sandwich structures for tensile, pressure, bending, and impact strengths. Of the six materials, two were PVC foams, two were tubular cellulose acetate foams, and two were polyurethane foams. Structures and properties of the materials and test conditions are briefly discussed. The results are presented in tables and graphs. Transl. by K.W.

N68-26116 State Univ. of Iowa, Iowa City.
A DIRECT METHOD OF ANALYZING AXI-SYMMETRIC ELASTICITY PROBLEMS
Ti-Chiang Lee (Ph.D. Thesis) 1967 139 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-9075

This work consists mainly of two parts. Part I discusses the problem of an axi-symmetric elastic solid under axi-symmetric loading when a cavity or a pit is symmetrically located inside or on the solid. The general expression for Love's stress function is first constructed in terms of Legendre polynomials which satisfies all the governing equations of the problem except the traction conditions prescribed either on the surface of the cavity or pit, or on the remaining surfaces of the solid. Then the boundary conditions are satisfied as closely as possible by means of the method of overdetermined collocation. Part II considers an elastic solid of revolution with a cavity inside the solid subjected to torsion at infinity. Michell's general solution of the torsion problem for the stesss function is expressed in terms of the associated Legendre polynomials of the second order. This general solution also satisfies all the governing equations except the boundary conditions on the surface of the cavity and on the remaining surfaces of the solid. Dissert. Abstr.

N68-26126# General Precision Systems, Inc., Little Falls, N. J. Aerospace Research Center.
STUDY OF MICROMECHANICAL PROPERTIES OF ADHESIVE BONDED JOINTS Quarterly Progress Report, 1 Jan.–31 Mar. 1968
Edward J. Hughes and John L. Rutherford 15 Apr. 1968 25 p ref
(Contract DAAA21-67-C-0500)
(QPR-3; AD-668245)

Contents: Temperature dependence of effective tensile modulus; Pre-strain dependence of effective tensile modulus; Cross head speed dependence of secant modulus; Precision elastic limit; and Temperature dependence of shear modulus. TAB

N68-26162 Michigan Univ., Ann Arbor.
A STUDY OF STRESS MEASUREMENTS USING THE THERMOELASTIC EFFECT
Robert Wallace Dunlap (Ph.D. Thesis) 1966 178 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-8245

A technique for measuring localized peak stresses in metallic specimens is proposed. The technique depends on the experimental measurement of the temperature changes in stressed members due to adiabatic elastic deformation. The technique appears suited for the measurement of stress concentration effects, for the temperature changes can be measured with intrinsic thermocouples featuring extremely small junctions. In the present study, a typical stress concentration geometry is investigated. The problem considered is the uniaxial loading of a finite width strip with a circular hole located on the axis of symmetry. This problem provides an apt model for study, since a theoretical stress state solution is available. Hence, heat transfer in this geometry due to the temperature gradients produced by adiabatic elastic deformation can be analyzed mathematically. It is shown that the measurement of a temperature change ratio can be used to determine the stress concentration factor for such a geometry, regardless of heat transfer effects at the locale of the stress concentration. Experimental results are then presented which show the feasibility of obtaining stress state information with the thermal measurement technique Author

N68-26185 California Univ., Berkeley.
THE SECOND-ORDER THEORY OF CYLINDERS OSCILLATING VERTICALLY IN A FREE SURFACE
Choung Mook Lee (Ph.D. Thesis) 1966 152 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-8597

Let a cylinder be half submerged with its generators parallel to the water surface, and suppose it to be symmetric about a vertical axis. Further suppose the cylinder to be oscillating harmonically in a vertical direction. The pressure distribution about the cylinder, the force acting upon it, and the waves generated by it are computed through the second order of a perturbation series in the ratio of amplitude of motion to beam. The resulting potential-theory problems are solved by placing singularities of all

orders at the intersection of the water surface with the vertical axis of symmetry and determining their strengths from the boundary condition on the body. Numerical computations are made for a circular cylinder and for a U-shaped cylinder. The results are presented in graphs. Dissert. Abstr.

N68-26186 California Univ., Berkeley.
SYNTHESIS AND ANALYSIS OF SPACE MECHANISMS WITH USE OF THE DISPLACEMENT MATRIX
Chung Ha Suh (Ph.D. Thesis) 1966 173 p refs
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-8657

An investigation of the domain of three-dimensional mechanisms involving finite displacements of rigid bodies is presented. Applications in the synthesis and the analysis of linkage mechanism for rigid body guidance, function generation, path generation, and other special purposes, are shown. A unique mathematical notation is first proposed such that it is adaptable to both synthesis and analysis of three-dimensional mechanisms, including plane and spherical mechanisms as special cases. To meet this purpose a generalized matrix for the description of spatial rigid body displacement is defined and developed. Synthesis and analysis of plane and spherical mechanisms with use of displacement matrices are described as special cases. Author

N68-26223 IIT Research Inst., Chicago, Ill.
LIMIT ANALYSIS OF ROTATIONALLY SYMMETRIC SHELLS THROUGH NONLINEAR PROGRAMMING
Andre Biron (Ph.D. Thesis) 1967 229 p
Available from Univ. Microfilms: HC $10.35/MF $3.00 Order No. 67-8898

A new method of limit analysis of rotationally symmetric shells is introduced whereby lower and upper bounds are obtained through a nonlinear programming code. For computational purposes, a specific shell configuration is considered, defined by the relation in dimensionless form $z = (1/\alpha)\, cr^q$ where z is the coordinate along the axis of symmetry, and r is the radius. The procedure consists essentially in combining a powerful minimization technique with the well-known theorems of limit analysis. For the lower bound computation, the shell generator is subdivided into a certain number of zones and the distribution of some of the stress components is described by simple functions in each zone. To establish the upper bound, a distribution of the velocity components is also defined by simple functions for each zone, and the value of the load associated with this kinematically admissible field is minimized. Dissert. Abstr.

N68-26232 Stanford Univ., Calif.
PERTURBATION SOLUTIONS FOR THE BUCKLING PROBLEM OF INITIALLY IMPERFECT, AXIALLY COMPRESSED COLUMNS AND SHELLS
Clive Lionel Dym (Ph.D. Thesis) 1967 98 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-7910

A two-part study is made of the use of perturbation techniques to obtain solutions for the buckling problem of initially imperfect structural elements. In the first part a study is made of the effect of initial deviations on the load carrying capacity of thin circular cylindrical shells under uniform axial compression. A perturbation expansion is used to reduce the non-linear equations of von Kármán-Donnell to an infinite set of linear equations, of which only the first few need be solved to obtain a reasonably accurate solution. The results for both infinite shells and shells of finite length indicate that a small imperfection can sharply reduce the maximum load that a thin-walled cylinder will sustain. In the second part, perturbation solutions for the differential equation governing dynamic buckling of an elastic column are discussed. A region of validity is suggested for a solution of Hoff's, and two alternate solutions are presented. Dissert. Abstr.

N68-26234 Stanford Univ., Calif.
EXTENSION CRITERIA FOR CRACKS DISTURBING UNIFORM HEAT FLOW
Frederic Armas Simonen (Ph.D. Thesis) 1967 145 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-7972

The two-dimensional (plane strain) and axisymmetric (penny-shaped crack) cases are considered for infinite bodies. Critical values of the undisturbed temperature gradient in terms of the crack dimensions and material properties are obtained. Both the Griffith and Barenblatt crack theories are applied, and their respective criteria are shown to be in agreement. However the Barenblatt theory eliminates the stress singularity present with the Griffith theory. The stress at the crack-tip is represented as an intense localized cohesive force loading. Both the Griffith and Barenblatt theories are discussed in detail. Calculations are given which show that their extension criteria are identical. This follows as a direct result of the hypothesis that all the work done against the cohesive forces during crack extension becomes crack surface energy. Dissert. Abstr.

N68-26246*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FRACTURE OF CRACKED PLATES UNDER PLANE STRESS
J. C. Newman, Jr. [1967] 34 p refs Presented at the Natl. Symp. on Fracture Mech., Bethlehem, Pa., 19–21 Jun. 1967
(NASA-TM-X-60200) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Dugdale's model for static yielding at the tip of a crack is extended to include the influence of the stress-strain curve on the plastic-zone size and subsequently on the fracture strength of the plate. The internal stresses acting on the boundary of an assumed extension of the crack line to the end of the plastic zone are expressed as a function of strain hardening, strain rate, and the state of stress. Thus, the plastic-zone size and the crack boundary displacements are calculated as a function of these factors for the plane stress condition. From these considerations, a fracture toughness equation which accounts for plasticity is derived for the uniformly loaded plate. Residual static strength tests on cracked plates for several aluminum alloys and steels at room temperature having widths ranging from 3 to 48 inches are analyzed. The gross stress predictions computed by using the modified Dugdale model are compared with the predictions computed by the ASTM method and Notch Strength Analysis method. The proposed method gave predictions that were more consistent with the test data. Author

N68-26252# Weidlinger (Paul) Consultants, New York.
SURFACE RESPONSE OF AN ELASTIC MEDIUM TO NORMAL PRESSURES APPLIED OVER CONSTANT AND EXPANDING CIRCULAR AREA
Giuseppe Modiano and Melvin L. Baron Nov. 1967 51 p refs
(Contract DA-30-069-AMC-8(R))
(TR-5; AD-668256)

The response of points at the surface of an elastic half-space due to applied normal pressures are determined for two distributions of the loads: (a) a uniform time decaying normal pressure applied over a fixed circular area on the surface $z = 0$; and (b) a time decaying pressure pulse which acts over a surface area of increasing radius. The surface displacements are obtained by means of integrations in space and time of the expressions, given by Pekeris, for the response of the medium to a concentrated point force with a step function distribution in time. A computer code has been developed for each loading case. Some typical numerical examples are presented. Author (TAB)

N68-26271# Harry Diamond Labs., Washington, D. C.
SHOCK SPECTRA
Paul G. Hershall Jan. 1968 37 p refs
(HDL-TM-67-18; AD-667935)

Numerical solutions in graphical form are presented for the shock spectra of a one-degree-of-freedom system subjected to some idealized forcing functions. Elementary procedures are outlined for developing the solutions. Analog and digital computer programs are submitted where applicable. Author (TAB)

N68-26284# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
STATISTICAL ANALYSIS OF TEMPERATURE DATA FROM WIND TUNNEL TEST OF A VON KARMAN RADOME
Manford B. Tate Mar. 1968 29 p refs
(Contract NOw-62-0604-c)
(TG-983; AD-668135)

Temperatures obtained from a wind-tunnel test on a Von Karman radome are studied and put into functional form for theoretical analysis of radome thermal stresses. It was found that the radome wall temperature can be expressed analytically by a single function that defines the temperatures at all points in the wall except for a short length near the tip for which another expression is developed. The single function is further separable by variables into two functions, one of which describes the spanwise distribution and the other, the wall-thickness distribution of the temperature. This finding is highly advantageous mathematically. The analytical and test results are presented and compared in three figures and recorded in two tables. Good agreement between experiment and analysis was found to exist with the difference range generally not in excess of approximately plus or minus 7 percent while being less than half this amount in most cases. The derived function overestimates the maximum temperatures by about 0.5 percent, but this is a conservative feature insofar as the theoretical prediction of thermal stress is concerned. The range of experimental error in the original data was reported by the test engineers to be also about plus or minus 7 percent. Author (TAB)

N68-26334 Brown Univ., Providence, R. I.
THE MEASUREMENT OF DYNAMIC STRAINS ON THE SURFACE OF OPAQUE BODIES USING BIREFRINGENT STRIPS
David Nelson Robinson (Ph.D. Thesis) 1966 63 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-2282

An experimental and analytical study is presented of the bonded birefringent strip as a means of observing transient deformations on the surfaces of opaque bodies. The particular situation investigated consists of a birefringent sheet bonded to a metal rod in which a strain pulse is initiated by a small explosive charge. A simple and reliable method of interpreting the observed fringe pattern is developed for linear elastic behavior of the sheet. Satisfactory agreement is obtained between the strain profile at the rod-sheet interface determined by using a birefringent strip and the profile given by resistance-wire strain gages. Two problems associated with the use of the technique are studied. The first is an investigation of the influence the sheet has on the strain pulse in the bar. The second is an analytical investigation of the effects of viscoelasticity in the sheet and their bearing on the applicability of the technique. Dissert. Abstr.

N68-26363# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
CURVATURE RADII AND DERIVATIVES FOR THERMAL-STRESS ANALYSIS OF VON KARMAN RADOMES
Manford B. Tate Mar. 1968 15 p refs
(Contract NOw-62-0604-c)
(TG-982; AD-668146)

Basic characteristics of the Von Karman radome configuration are examined and evaluated. Both general and specific results are developed that are required in analyses of stresses, heating effects, and aerodynamic behavior. As a numerical example, the envelope curve for all the principal radii of curvature is obtained for a 28.3 x 6.75 inch Von Karman radome. The numerical results are given in two tables and plotted in two figures. A graphical construction is also included to illustrate the relationship between parametric forms and other coordinates that define the profile curve. Author (TAB)

N68-26403# Texas Univ., Austin. Dept. of Aerospace Engineering.
AEROELASTIC STABILITY CHARACTERISTICS OF CYLINDRICAL SHELLS CONSIDERING IMPERFECTIONS AND EDGE CONSTRAINT
Gerald W. Barr and Ronald O. Stearman Jan. 1968 37 p refs
(Grant AF-AFOSR-1234-67)
(AFOSR-68-0382; AD-668074)

Recent wind tunnel results indicate that the existing cylindrical shell aeroelastic stability theories are generally nonconservative. Therefore, some type of destabilizing mechanism is needed in the present theory to enhance correlation with experiment. In the paper, the dynamic stability behavior of thin circular cylindrical shells subjected to a supersonic flow field is investigated theoretically and compared with existing experimental data. Combined effects of axisymmetric initial geometric imperfections, radial edge constraint, and prestability deformations are considered. The cylinders motion is described with nonlinear Donnell type shell equations coupled with a linear piston theory aerodynamic approximation. A modal type approach employing Galerkins approximate technique is used to investigate the dynamic stability about the shells deformed middle surface. Prestability deformations alone have been shown to have very little influence on the aeroelastic stability behavior of very thin shells. However, with the inclusion of initial imperfections, the combined effect is destabilizing. The resulting aeroelastic stability boundaries correlate quite well with existing experimental data. Author (TAB)

N68-26423 Brown Univ., Providence, R. I.
AN OPTIMAL SOLUTION OF SAINT-VENANTS FLEXURE PROBLEM FOR A CIRCULAR CYLINDER
David Beauregard Bogy (Ph.D. Thesis) 1966 41 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2219

In a recent paper Sternberg and Knowles established certain minimum strain-energy properties of Saint-Venant's solutions to the relaxed Saint-Venant problem for an elastic cylinder. They proved that Saint-Venant's solutions for the case of extension, pure bending, and torsion are uniquely distinguished, among all solutions to the appropriate relaxed problem that correspond to a fixed resultant load and to point-wise vanishing shearing or normal terminal tractions, by the fact that they minimize the total strain energy. In the same paper Saint-Venant's solution for the case of bending by transverse terminal loads was shown to be no longer optimal in the foregoing sense and the optimal flexure solution was characterized implicitly as the solution to a mixed-mixed boundary-value problem for the cylinder in question. In the present investigation this optimal flexure solution is determined explicitly for a circular cylinder by means of the Papkovich-Neuber stress functions. Author

N68-26444# Naval Ordnance Lab., White Oak, Md.
A DYNAMIC VIBRATION ABSORBER FOR TRANSIENTS
Dirse W. Sallet 3 Mar. 1968 32 p refs
(NOLTR-67-60; AD-668168)

The principle of the dynamic vibration absorber was applied to reduce in a defined manner transient vibrations of a one degree of freedom system. Ten rules were developed which relate the

position of the roots of the characteristic equation to the physical parameters. The concept of the relative and the absolute influence position is introduced; these new definitions refer to a particular position of the roots of the characteristic equation when only the spring constant, or, respectively, the spring constant and the damping coefficient between the masses are variable. Author (TAB)

N68-26499# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Advanced Development Program.
COMPUTER SOLUTION OF WEIGHT OPTIMIZED DIMENSIONS FOR CONTROL SYSTEM JOINTS
W. D. Craig, Jr. May 1968 11 p
(FSN-AD5-05-68.2)

A computer program is shown for determining the optimum dimensions of the connecting lugs and rod end for minimum weight control system pivot joints. The bearing dimensions, design load, and allowable stress in fittings are used as input data. The effect of bearing friction during rotation and misalignment are taken into account. Author

N68-26532 Brown Univ., Providence, R. I.
ANALYSIS OF PLASTIC SPHERICAL SHELLS
Li-chih Lee (Ph.D. Thesis) 1966 55 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2261

Complete numerical solutions are obtained for built-in spherical sandwich shells subjected to hydrostatic pressure. The shell material is assumed to obey Tresca's yield condition and flow rule. Dissert. Abstr.

N68-26550# Naval Ordnance Lab., White Oak, Md.
AN ANALYSIS OF THE SPLIT HOPKINSON PRESSURE BAR
James L. Rand 2 Oct. 1967 81 p refs
(NOLTR-67-156; AD-668166)

The purpose of the paper is to analyze in detail many of the assumptions and techniques often employed to obtain stress-strain relations at rates of strain of approximately 1000/sec. The effects of axial wave propagation and interaction detail in short cylindrical specimens on the resulting stress-strain relation were evaluated in detail. The effect of specimen geometry on the end effects associated with friction was demonstrated both theoretically and experimentally. Author (TAB)

N68-26626 Brown Univ., Providence, R. I.
TWO STUDIES IN ANELASTICITY
Larry Steven Shu (Ph.D. Thesis) 1966 55 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-2288

The thesis consists of two parts: Part I, "Finite deformations of an extensible plastic arch," deals with finite deformations of a rigid perfectly plastic circular arch in the presence of extensions caused by axial forces. Part II, "On anisotropic linear viscoelastic solids," is devoted to a study of the restrictions implied on the relaxation moduli of an anisotropic linear viscoelastic solid by the requirement that the work done to deform a virgin element be non-negative. It is shown that if the work is non-negative, then the tensor of relaxation moduli is fully symmetric at time zero and that it can be represented by certain Fourier–Stieltjes integrals. Conversely, if the relaxation moduli are representable by the same Fourier–Stieltjes integrals, then the work done is non-negative. It is also shown, by means of a counter example, that the requirement of non-negative work is not sufficient to insure the full symmetry of the tensor of relaxation moduli for all times. Dissert. Abstr.

N68-26629# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
COMPOUND-OGIVE RADOMES AS SUBSTITUTE STRUCTURES FOR VON KARMAN SHAPES
Manford B. Tate Mar. 1968 27 p refs
(TG-985; AD-668142)

A tangent-ogive and three compound-ogive radomes are examined for use of one of them as a substitute structure in analysis of Von Karman radome thermal stresses. A tricentric ogive-cone radome is chosen as the substitute, because it provides a highly satisfactory representation of the Von Karman profile both in regard to approximate duplication of cross-sectional radii and coordinate angles for nearly all values of the spanwise variable. The introduction of a substitute structure is made necessary by the absence of stress solutions for the Von Karman profile type of structure in current and past technical literature, but a theoretical solution for ogive shapes is available. Also, the temperature distribution obtained in previous investigations on the Von Karman test radome is herein successfully imposed on the substitute structure with results that agree within two percent of those computed from formulas that were obtained in the earlier studies. Author (TAB)

N68-26648# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VIBROMETRY
Yu. I. Iorish 7 Jul. 1967 891 p refs Transl. into ENGLISH of the book "Vibrometriya" Moscow, Moskgiz., 1963 p 1–772
(FTD-MT-65-217; AD-668226)

This book considers the measurement of vibrations and shocks in machines and equipment. It includes sections on vibrations which must be known to understand the physical processes that take place in vibration measuring equipment. The general theory of vibration measuring equipment, a description of the equipment and its elements, particularly mechanical vibration gauges, methods of testing and calibrating equipment, recommendations for the organization of the measurements, and methods of analyzing the vibrograms are given in the book. The book is intended for researchers and engineers who study mechanical vibrations in the various branches of technology and for designers of measuring equipment. The book can also be an aid to students in mechanical and polytechnic higher education institutions. The chapters directly relating to the technique of measuring vibrations can be used by middle technical personnel. TAB

N68-26708* Wyle Labs., Inc., Huntsville, Ala.
PREDICTED VIBRATION RESPONSES OF APOLLO STRUCTURE AND EFFECTS OF PRESSURE CORRELATION LENGTHS ON RESPONSE
R. W. White Mar. 1968 75 p refs Revised
(Contract NAS9-5810)
(NASA-CR-92168; WR-67-4) CSCL 22B

To determine the degree of response simulation that could be expected for such qualification testing of the Apollo Spacecraft, responses of a segment of the Apollo structure were estimated theoretically for both acoustic and flight environments. The vibration analysis presented in this report was performed for the Spacecraft Lunar Module Adaptor; and the three environments treated are turbulence at Mach 1 and Mach 2, a reverberant acoustic field, and a modified acoustic progressive wave field. The purpose of the analysis was to determine the effects of surface pressure correlation lengths on the response characteristics of representative Apollo structure, and to select on this basis, the optimum acoustic environment for structural vibration qualification tests of the Apollo in the Spacecraft Acoustic Laboratory. The method of analysis employed consists of determining, independently, the space average, mean-square acceleration spectral density for each of the significant modes of vibration of an equivalent cylindrical shell, and then expressing the total structural response as a linear summation of these modal responses. Author

N68-26738# North Carolina State Coll., Raleigh. Applied Mathematics Research Group.
THE STRESS INTENSITY FACTOR FOR A GRIFFITH CRACK IN AN ELASTIC BODY IN WHICH THERE IS AN ASYMMETRICAL DISTRIBUTION OF BODY FORCES
Ian N. Sneddon and John Tweed 2 Apr. 1968 53 p refs
(Grant AF-AFOSR-444-66)
(AFOSR-68-0852; AD-668461)

The paper deals with the problem of determining the distribution of stress in the vicinity of a Griffith crack in a solid when body forces are acting in the solid. The work considers the solution of this problem when body forces are not distributed symmetrically with respect to the faces of the crack. Author (TAB)

N68-26744# State Univ. of New York at Buffalo. Faculty of Engineering and Applied Sciences.
DYNAMICS OF RECTANGULAR PLATES
Yu-Chung Lee and Herbert Reismann Mar. 1968 45 p refs
(Grants AF-AFOSR-988-67; NIH FR-00126; NSF GP-7318)
(AFOSR-68-0577; Rept.-30; AD-668459)

The dynamic response of a simply supported rectangular plate is treated within the framework of classical, three-dimensional elasticity theory. The plate is subjected to a suddenly applied, uniformly distributed transverse load over a rectangular area, the sides of which are parallel and perpendicular to the sides of the plate. An exact solution in series form is given, and a comparison of this solution with previously obtained corresponding solutions within the framework of classical and improved plate theories is also presented. Author (TAB)

N68-26748# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE EFFECT OF INITIAL BUCKLING ON THE STABILITY OF FINNED CYLINDRICAL SHELLS UNDER AXIAL COMPRESSION [O VLIYANII NACHAL'NYKH PROGIBOV NA USTOYCHIVOST' REBRISTYKH TSILINDRICHESKIKH OBOLOCHEK PRI OSEVOM SZHATII]
I. Ya. Amiro et al 25 Aug. 1967 26 p refs Transl. into ENGLISH from Prikl. Mekh. (USSR), v. 2, no. 1, 1966 p 53–58, 141–143
(FTD-HT-66-785; AD-668117)

Contents: The effect of initial buckling on the stability of finned cylindrical shells under axial compression; and Conference on problems of high-temperature strength. TAB

N68-26832*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DAMPERS TO SUPPRESS WIND-INDUCED OSCILLATIONS OF TALL FLEXIBLE STRUCTURES
Wilmer H. Reed, III and Rodney L. Duncan [1967] 26 p refs Presented at the 10th Midwestern Mech. Conf., Ft. Collins, Colo., 21–23 Aug. 1967
(NASA-TM-X-60432) CFSTI: HC $3.00/MF $0.65 CSCL 20K

On the basis of wind-tunnel studies with an aeroelastic model of the Saturn 5 launch vehicle, viscous dampers were installed on the full-scale structure to assure against excessive ground-wind-induced oscillations. Also described is a simple but effective damper recently developed to alleviate wind-induced oscillations on a U.S. Navy antenna system. This damper, which consists of chains hanging in containers, is a form of impact damper and appears to have many potential applications. A progress report on a generalized research investigation of hanging-chain dampers is included. Author

N68-26871# Applied Technology Associates, Inc., Ramsey, N. J.
STRESS ANALYSIS FOR A SPHERICAL SHELL PERFORATED BY MANY RADIAL HOLES
Robert Rung and Vito L. Salerno Jan. 1968 42 p refs Prepared for Union Carbide Corp., Oak Ridge, Tenn.
(Contract W-7405-ENG-26)
(TID-24309; Rept.-118) CFSTI: HC $3.00/MF $0.65

A point-matching method using assumed functional forms for the Airy stress function is applied to the two-dimensional problem of closely spaced holes in a regular triangular pattern. Compatibility is satisfied at discrete points in the field and boundary conditions and are also specified at particular points. The method is extremely sensitive numerically and is not considered suitable for calculations for analysis and design parametric studies. Author (NSA)

N68-26916# Houston Univ., Tex. Dept. of Mechanical Engineering.
FILTERING CHARACTERISTICS OF A LONG CYLINDRICAL STEEL BAR WITH DISCONTINUITIES IN ITS CROSS-SECTIONAL AREA
J. D. Bruner and D. Muster Oct. 1967 27 p refs
(Contract Nonr-4492(01))
(TR-8; AD-668175)

In terms of a mechanical-electrical analogy, a four-terminal electrical network is synthesized which has the characteristics of string of drill pipe subjected to longitudinal vibrations. Electrically, it is a Pi-section band-pass filter composed of passive, non-dissipative components which take their properties from the physical characteristics of the mechanical system, including the distance between discontinuities and the area ratios at the discontinuities. The attenuation characteristics of a typical drill string model are given as a function of frequency. The pass- and stop-bands for the system are discussed. Author (TAB)

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N68-25689*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LIQUID ROCKET COMBUSTION: AN AERODYNAMICALLY CONTROLLED PROCESS
Richard J. Priem Washington 1967 46 p refs Presented at the 18th Astronautical Congr., Belgrade, 24–30 Sep. 1967; Sponsored by the Intern. Astronautical Federation
(NASA-TM-X-52334) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Research was conducted to describe the various processes in the conversion of liquid propellants to reacted gases. These processes include liquid phase mixing and reaction, spray formations, drop formation (atomization), vaporization, gas phase mixing, and chemical reaction. The knowledge gained was used to describe analytically the combustion in actual engines with the appropriate environmental and boundary conditions. By this procedure, it was concluded that combustion is controlled primarily by aerodynamic effects. Also included is a description of how combustor performance (characteristic exhaust velocity) can be predicted for inefficient combustion systems. To show the validity of the information presented, the results obtained by using information known about each process in combustion are compared with measurements made in or with actual liquid rocket engines. R.N.A.

N68-25698*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

VAPOR-PRESSURE DATA EXTRAPOLATED TO 1000 ATMOSPHERES FOR 10 REFRACTORY ELEMENTS WITH THERMAL ABSORPTION CROSS SECTIONS LESS THAN 5 BARNS

Charles C. Masser Washington 1967 34 p refs Presented at the 4th Symp. on Thermophys. Properties, College Park, Md., 1–4 Apr. 1968; sponsored by ASME

(NASA-TM-X-52329) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Increased interest in high-temperature technology makes knowledge of the vapor pressure of refractory materials more important. We have collected existing vapor-pressure data for 10 elements (C, Ce, Mo, Nb, Pt, Ru, V, W, Y, Zr). These have atmospheric boiling points over 3000°K and thermal absorption cross sections less than 5 barns. Data were discussed and extrapolated to 1000 atmospheres. An error analysis was used to indicate the error in temperature at a given pressure introduced by scatter in the original data. At 1000 atmospheres, zirconium has the highest boiling point (10,100°K). Author

N68-25726*# Techtran Corp., Glen Burnie, Md.

FILM COOLING DURING INJECTION OF HETEROGENEOUS SUBSTANCE IN A TURBULENT BOUNDARY LAYER [ZAGRADITEL'NOYE OKHLAZHDENIYE PRI PODACHE INORODNOGO VESHCHESTVA V TURBULENTNYY POGRANICHNYY SLOY]

E. P. Volchkov, Ye. G. Zaulichnyy, S. S. Kutateladze, and A. I. Leont'yev Washington NASA May 1968 9 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. i Techn. Fiz. (Moscow), no. 2, 1967 p 103–106

(Contract NASw-1695)

(NASA-TT-F-11695) CFSTI: $3.00 CSCL 20M

The effectiveness of film cooling a heat insulating plane wall during local injection of a heterogeneous substance into the boundary layer is described. The turbulent boundary layer is formed on a solid wall behind the zone of injection. It is assumed that heat flow through the wall is zero. The cooling gas is injected through a tangential slit or through a porous section. If a liquid substance is used or if chemical reactions occur in the initial plate section, the effect of the products formed is considered to be the same as of a heterogeneous substance. Author

N68-25769*# National Aeronautics and Space Administration, Washington, D. C.

EXPERIMENTAL INVESTIGATION OF HEAT AND MASS TRANSFER IN THE REACTING BOUNDARY LAYER ON A POROUS PLATE [EKSPERIMENTAL'NOYE ISSLEDOVANIYE TEPLO- I MASSOOBMENA V REAGIRUYUSHCHEM POGRANICHNOM SLOYE NA PORISTOY PLASTINE]

L. I. Tarasevich May 1968 10 p refs Transl. into ENGLISH from the Publ. "Obshchiye Voprosy Teplo i Massoobmena" Minsk, Nauka i Tekhn. Press, 1966 p 37–47

(NASA-TT-F-11692) CFSTI: $3.00 CSCL 20M

Intensive heat fluxes and high temperatures in contemporary combustion chambers and heat exchangers cause damage to the structural elements; the damaged elements can enter into chemical reactions with each other or with the external environment. In the present study, a special low velocity wind tunnel containing a porous plate mounted on the lower wall of the closed 280×340 mm test section was used, with air flow rate over the plate varying from 1 to 8 m/sec. Air temperature varied from 288 to 393°K. Ethyl alcohol was used as the reacting liquid, injected through the plate surface. The study showed that the heat liberated during the chemical reaction was partially transferred to the plate, used to evaporate the reacting liquid, and partially dissipated by the air flow. The heat and mass transfer in the reacting laminar boundary layer are analyzed. Author

N68-25770# Central Mechanical Engineering Research Inst., Durgapur (India).

EFFECT OF TURBULENCE ON PREMIXED GASEOUS FLAMES

D. Bhaduri Feb. 1968 10 p refs *Its* CMERI Rept. No. 86

CFSTI: HC $3.00/MF $0.65

A new analysis for the investigation of combustion in turbulent premixed gaseous mixtures is presented. The processes of heat and mass transfer, considered jointly at the flame front, introduce an aerodynamic criterion $^{e}T/Ud$ for the evaluation of burning velocity in turbulent stream. Owing to the presence of a relationship between $^{e}T/Ud$ and Re, the linear variation of U_T with Re is valid only below a critical Re, after which U_T becomes independent of the velocity of flow. A 'mixed' model in the presence of a gradual transition from the model of wrinkled laminar flame to that of homogeneous combustion in volume, is proposed with a note that the criterion $^{e}T/Ud$ may be an alternative of Kovasznay criterion for assessing the mode of combustion in turbulent stream. Author

N68-25793*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOME EFFECTS OF UNCOOLED PIPE INLET GEOMETRY AND CONE ANGLE ON THE TURBULENT BOUNDARY LAYER AND HEAT TRANSFER IN CONICAL NOZZLES OPERATING WITH AIR

Donald R. Boldman, James F. Schmidt, and Robert C. Ehlers 1967 36 p refs Presented at the 9th Natl. Heat Transfer Conf., Am. Soc. of Mech. Eng., Seattle, 6–9 Aug. 1967

(NASA-TM-X-52213) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Boundary layer and heat-transfer measurements are presented for conical nozzles having half angles of convergence of 30° and 60°, each operating with a short and long uncooled pipe inlet. The long inlet, which produced a fully developed turbulent boundary layer at the nozzle entrance, did not significantly alter the nozzle heat transfer relative to values obtained with the short inlet. A reduction in inlet diameter effected a pronounced increase in the throat heat transfer. Appreciable increases in the throat heat transfer accompanied an increase in nozzle convergence angle. Both a correlation and boundary layer method failed to provide a good prediction of the throat heat transfer; however, better agreement was obtained with the boundary layer theory. All tests were conducted in air at stagnation conditions of 300 psia and 970°R corresponding to throat Reynolds numbers of about 5×10^{6}. Author

N68-25806*# Lockheed Missiles and Space Co., Huntsville, Ala. Thermal Environment Section.

THE EFFECTS OF SHOCK LAYER RADIATION AND VISCOUS COUPLING ON THE TOTAL HEATING RATE TO A REENTERING BLUNT BODY

L. W. Spradley and C. D. Engel NASA Apr. 1968 44 p refs Prepared for Northrop Nortronics, Norwood, Mass.

(Contract NAS8-20082)

(NASA-CR-61224; LMSC/HREC-A791241) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Some results of a study of coupled convective and radiative heat transfer to vehicles entering planetary atmospheres at superorbital velocities are presented. The flow field about a blunt body in a hypersonic stream is described by a coupled set of conservation equations which are solved numerically using a combination of integral methods and successive approximation techniques. The effects of mass injection, radiative emission and absorption, and coupling between convection and radiation are included in the analysis. The spectral absorption coefficients of the shock layer gas are formulated as functions of temperature, radiation frequency and particle number density. Results obtained for stagnation region convective and radiative heating rates and shock layer profiles are

presented for several flight conditions in equilibrium air. Heating rates for a typical lunar type trajectory are also presented. Results of this analysis indicate that the coupling effect of radiation cooling can significantly reduce the total heat transfer to a superorbital entry body. Author

N68-25809# Central Mechanical Engineering Research Inst., Durgapur (India).
A STUDY OF PULSATING COMBUSTION
D. Bhaduri, C. B. Baxi, and B. S. Gill Dec. 1967 13 p refs
(B5) CFSTI: HC $3.00/MF $0.65

The paper presents a new theoretical analysis of the phenomenon of pulsating combustion. A mathematical model has been proposed for a thermal instead of an acoustical approach for the investigation of pulse combustion system. This leads to the prediction of a few important parameters such as frequency, pressure amplitude and temperature-time variation at a point in the pulse combustor. A Helmholtz pulse combustor has been designed and a few theoretical viewpoints have been verified experimentally. A pulse heater and an insecticide sprayer fitted with a pulse engine have been developed on the basis of the analysis presented. Author

N68-25855*# Techtran Corp., Glen Burnie, Md.
PROBLEMS ASSOCIATED WITH THE CALCULATION OF FRICTION AND HEAT TRANSFER IN A TURBULENT BOUNDARY LAYER [PROBLEMY RASCHETA TRENIYA I TEPLOOBMENA V TURBULENTNOM POGRANICHNOM SLOYE]
V. S. Avduyevskiy and V. N. Kalashnik Washington NASA Apr. 1968 24 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Energ. i Transp. (USSR), no. 5, 1967 p 9–24
(Contract NASw-1695)
(NASA-TT-F-11663) CFSTI: $3.00 CSCL 20M

Effect of the Mach number, pressure gradient, surface roughness, and similar parameters on the friction and heat transfer in a turbulent boundary layer is discussed. The existing empirical formulas and semi-empirical methods for calculating these parameters, while based on experimentally determined friction and heat transfer laws, are in poor agreement with experimental data in the case of large Mach numbers, compressible boundary layers on a rough surface, and certain other values of the parameters. Semi-empirical methods do not permit extrapolation beyond the critical values for which the empirical relations (on which these methods are based) were derived. To improve this situation, it is necessary to refine the physical ideas on which these theories are based and to develop calculation methods applicable over a wider range of parameter values by using more rigorous physical relations for turbulent boundary layer flows. Author

N68-25857# Technische Hochschule Munchen (West Germany).
BOILING HEAT TRANSFER NEAR THE CRITICAL STATE [WAERMEUEBERGANG BEIM SIEDEN IN DER NAEHE DES KRITISCHEN PUNKTES]
Esref Abadzic 1967 86 p refs In GERMAN; ENGLISH summary
CFSTI: HC $3.00/MF $0.65

Boiling heat transfer on a horizontal platinum wire was studied for CO_2 and F 13 near the critical state, and ether far away from this state. Nucleation was hampered by the purity of the test materials, so that heat transfer curve is divided into three unsteadily merging branches. In nucleate boiling, the influnce of hydrodynamic forces was shown. In film boiling, the rising vapor assumed peculiar regular patterns. The pressure influence on heat transfer appeared to be significant in nucleate boiling but negligible in film boiling. Author

N68-25917*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC-TEMPERATURE DISTRIBUTION IN A FLAT PLATE COMPRESSIBLE TURBULENT BOUNDARY LAYER WITH HEAT TRANSFER
S. Z. Pinckney Washington Jun. 1968 45 p refs
(NASA-TN-D-4611) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An expression based on the differential equations for the local energy transfer and shear is derived for the relationship between the static temperature and the velocity in a zero-pressure-gradient turbulent boundary layer. The boundary conditions imposed by these governing equations showed the temperature-velocity relation to be at least a fourth degree polynomial which differs considerably from the second degree polynomial obtained by previous investigators. These governing equations are integrated by using as boundary conditions the value of a particular total-energy-deficiency parameter of the boundary layer at the station under consideration, the slope of the laminar-sublayer temperature-velocity profile at the wall (as determined from a modified Reynolds analogy), and the local free-stream and wall conditions. Results obtained by this method are compared with experimental temperature-velocity profile data and are found to correlate well with the experimental profiles. Author

N68-26007 Michigan Univ., Ann Arbor.
THERMAL RADIATION INTERACTION IN LAMINAR FREE CONVECTION
Lynn Holt Blake (Ph.D. Thesis) 1966 150 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8218

This investigation considers the effect of radiation upon the natural convection flow. The total heat transfer from the vertical flat plate model was shown to be a function of the absorption and emission properties of the gas medium. The boundary layer equations with a radiation term in the energy equation were solved. From the solutions for the temperature field, total heat transfer rates were obtained. In the theoretical study, the radiant energy flux was approximated at two extremes of the Bouguer number. The boundary layer equations were solved for both the optically thick and optically thin gas cases. The optically thick gas solutions were obtained by similarity analysis as a function of the radiation parameter N, which is defined as the ratio of the magnitudes of conduction and radiation heat flux. The total heat transfer increased significantly as N decreased from 10. Optically thin gas results showed the radiation interaction decreased the net radiation heat transfer and increased the convective heat transfer from the plate. Dissert. Abstr.

N68-26021# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
THE DETERIORATION IN HEAT TRANSFER TO FLUIDS AT SUPER-CRITICAL PRESSURE AND HIGH HEAT FLUXES
Bharat S. Shiralkar and Peter Griffith 1 Mar. 1968 61 p refs
(Rept.-70332-51)

To determine the causes and conditions leading to a supercritical burnout, an experimental and theoretical investigation of heat transfer at high heat fluxes was undertaken. Because of its convenient critical range, CO_2 was used as the working fluid. To obtain a theoretical solution, the problem was treated as that of heat transfer to a single phase, turbulent flow with variable properties. Simultaneous differential equations governing the momentum and energy balance in the fluid were used for the solution. A detailed experimental program was undertaken to verify the computed results; the apparatus consisted of a closed circulation loop in which the system pressure is maintained with a hydraulic accumulator using high pressure nitrogen gas. It was concluded: (1) A region of deteriorated heat transfer can occur with high heat

fluxes at supercritical pressure as long as the bulk temperature is below the pseudo-critical temperature. (2) Deterioration can occur in either up or down flow. (3) The occurrence of the deteriorated region can be predicted reasonable well, but post-deterioration behavior cannot because of inadequacies in the expressions used for eddy diffusivity. M.G.J.

N68-26044 Arkansas Univ., Little Rock.
THERMAL CONDUCTIVITY OF SUSPENSIONS
Alfred Leo Baxley, Jr. (Ph.D. Thesis) 1967 169 p
Available from Univ. Microfilms: HC $7.80/MF $3.00 Order No. 67-8703

An experimental and theoretical study was conducted to establish a theoretically sound and numerically accurate technique for prediction of two-phase system thermal conductivity. Experimental data were gathered with the aid of a concentricsphere type apparatus. Thermal conductivities were measured for representative volume fractions of several liquid-solid systems. These systems include Aluminum-Polypropylene Glycol (PPG), Aluminum Oxide-PPG, and Selenium-PPG. Solids volume fractions ranged from 0.10 to 0.50 and the ratio of discontinuous phase to continue phase (liquid) conductivities ranged from 37.1 to 1584. A digital simulation technique was proposed to predict thermal conductivity of two-phase liquid-solid systems. The model used as a basis a constant density function random placement of solid cubes within a large cubical liquid system. The model considered three-dimensional heat conduction, potential field interaction, the thermal conductivities of both phases, and the volume fraction of the discontinuous phase. Dissert. Abstr.

N68-26180 California Univ., Davis.
BOILING HEAT TRANSFER IN AQUEOUS SOLUTIONS
Parviz Valandani (Ph.D. Thesis) 1966 121 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-8890

This work consists of two parts, an analytical study of nucleate boiling and an experimental investigation of boiling heat transfer in aqueous solutions. An analytical model for nucleate boiling is proposed that incorporates recent experimental observations concerning the behavior of the thermal layer adjacent to the wall, and the variations of the temperature field around the nucleation site during the ebullition cycle. Based on this model, the problem of heat transfer in pool boiling of saturated liquids was formulated. An approximate analytical solution of the problem was obtained by assuming constant wall temperature. Boiling experiments were performed with aqueous solutions of sucrose, dextrose, glycerol and ethylene glycol, on an electrically heated platinum wire. The nucleation characteristics of the wire surface were improved and stabilized by boiling a one percent NaCl solution on the surface. The wire was used both as the heating element and as a resistance thermometer for the measurement of the average wire temperature. The effects of electrolysis, additives, agitation and bath temperature on boiling heat transfer were qualitatively studied. Dissert. Abstr.

N68-26187 Michigan Univ., Ann Arbor.
HELIUM-HYDROGEN LIQUID-VAPOR EQUILIBRIUM TO ONE HUNDRED ATMOSPHERES
Carl Miller Sneed, Jr. (Ph.D. Thesis) 1966 134 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-8345

Experimental vapor and liquid phase compositions are given for the binary system hydrogen-helium over a temperature range of 15.5 to 29.8°K and 500 to 1500 psia. Eleven isotherms are shown for normal hydrogen, and three isotherms are duplicated with para-hydrogen as the mixture component. The mixture critical curve is located down to nearly 28°K, and the solidification curve given from 15.5° to nearly 17°. The locus of the barotropic phenomenon (gravitational phase inversion) is shown from 15.5° at 369 psia up to an intersection with the critical curve. The experimental apparatus consists of a vapor recirculating equilibrium system with the cell immersed in a vapor pressure controlled liquid hydrogen bath that is electrically heated for prompt approach to equilibrium. The liquid position in the cell is determined by a fixed bank of carbon resistors used as sensors. Temperatures are controlled to high precision and read on a calibrated platinum resistance thermometer with a Mueller bridge to 0.01 degree. Pressures are read on a 16" temperature compensating Heise bourdon tube gage to ±1.5 psi. The analysis of phase compositions is made on a mass spectrometer. Dissert. Abstr.

N68-26226 Iowa State Univ. of Science and Technology, Ames.
THERMODYNAMICS OF THE SOLUTION OF MERCURY METAL
James Nelson Spencer (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8937

The temperature dependence of the solubility of mercury in seventeen solvents has been measured. The solubilities at 25°C were found to vary from 10^{-5} to 10^{-8} moles/l for aromatic and aliphatic hydrocarbons and ethers and approximately 10^{-7} moles/l for water and perfluorodimethylcyclobutane. The solutility parameter equations developed by Hildebrand and Scatchard give calculated values of the mercury solubilities at 25°C which agree well with the experimental in most systems. It has been shown that this agreement is due to a cancellation of several factors. A modification of the original Hildebrand equations due to Reed was tested and found not to give as good agreement with experimental solubilities as the simple solubility parameter theory. The partial entropies of solution of mercury were determined from the temperature dependence of the mercury solubilities. The experimental entropies were found to differ from ideal. Dissert. Abstr.

N68-26303*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A REVIEW OF THE STATUS OF SPACECRAFT THERMAL CONTROL MATERIALS
E. R. Streed and J. C. Arvesen [1967] 14 p refs Presented at the Soc. of Aerospace Mater. and Process Engr. 11th Natl. Symp., St. Louis, 19–21 Apr. 1967
(NASA-TM-X-60408) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Engineering applications of various materials used for spacecraft passive temperature control are reviewed. Although selection depends primarily upon the thermophysical properties, the influence of solar ultraviolet radiation, electrons, protons, and temperature in a high vacuum environment must be carefully considered. The effects of ultraviolet spectral distribution, particulate (protons and electrons) radiation energy and flux, combined environment synergisms, and oxygen bleaching are presented for typical thermal control materials. Results of laboratory studies and flight stability experiments illustrate the need for more sophisticated simulation techniques to realistically evaluate these materials. Alternate design techniques utilizing new materials are shown to be potentially capable of stable performance for extended missions. Author

N68-26325 Michigan Univ., Ann Arbor.
FILM BOILING OF POTASSIUM ON A HORIZONTAL PLATE
Andrew Padilla, Jr. (Ph.D. Thesis) 1966 125 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-8323

The purpose of investigation was to experimentally determine the heat transfer to potassium in the stable film-boiling regime. The heat flux-temperature difference at various pressures were obtained. The liquid potassium was slowly charged to a hot surface at low pressure, thus establishing film boiling directly without passing over

the maximum heat flux. The film-boiling curve was then obtained by raising or lowering the power to the heaters. Film boiling data were obtained for pressures between 2 mm Hg and 300 mm Hg. Nucleate boiling data were also obtained for pressures of 1–2 mm Hg and 602–751 mm Hg. Heat fluxes up to 63,600 BTU/hr-sq ft were obtained for temperature differences between 15°F and 49°F. The heat fluxes encountered for the film boiling of potassium were substantially above the theoretical predictions of Zuber and Berenson. Dissert. Abstr.

N68-26355 Michigan Univ., Ann Arbor.
TURBULENT NATURAL CONVECTION IN AIR ALONG A VERTICAL FLAT PLATE
Charles Young Warner (Ph.D. Thesis) 1966 121 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-8360

Extensive measurements of temperature and heat transfer were obtained from the two-dimensional natural convection of air past a vertical flat plate at uniform temperature, for Grashof Numbers up to 10^{12}. Local heat flux measurements along the vertical coordinate of the plate are reported for four plate temperature levels. Measured temperatures within the boundary layer are presented for plate-to-probe distances ranging from 0.0005 to 12 inches. The temperature measurements indicate a very poor agreement with the 1/7 power law customarily assumed for the turbulent case, and evidence is given for the inaccuracy of the early measurements on which it was based. A strong similarity between the inner portion of the laminar and turbulent temperature profiles is noted, when plotted on natural coordinates. A discussion of problems and suggested techniques relative to the measurement of the velocity field is given. It is shown that the small magnitude of the velocities encountered, coupled with the presence of the temperature field and large fluctuations in all properties, puts this flow beyond the reach of present anemometry techniques. Dissert. Abstr.

N68-26380 Minnesota Univ., Duluth.
A NEW METHOD OF MEASURING THE MASS DIFFUSION COEFFICIENT AND THERMAL DIFFUSION FACTOR IN A BINARY GAS SYSTEM
Ji-wu Yang (Ph.D. Thesis) 1966 151 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-7805

An experimental method is developed for measuring the mass diffusion coefficient and the thermal diffusion factor of a binary gaseous mixture. It is based on a combination of convective and diffusive flow. The light one of the two gases is admitted at the top of a vertical tube and flows slowly downward. Drifting past the open lower end of the tube is the heavier gas which moves in a direction normal to that of the light flow. Consequently, the concentration of the lighter gas is diluted by the presence of heavier gas due to diffusive flow. Therefore a concentration gradient is established in the vertical tube and a corresponding temperature gradient is generated by the diffusion-thermo effect. By applying the conservation laws of mass and of heat for the tube flow, information on the two diffusion coefficients can be obtained. A temperature-concentration probe is used to measure the distribution of temperature and concentration. Concentration analysis is done by a thermal conductivity cell. The helium-nitrogen binary gas is investigated. Dissert. Abstr.

N68-26397# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF HEAT TRANSFER TO ORGANIC LIQUIDS [ISSLEDOVANIYE TEPLOOTDACHI K ORGANICHESKIM ZHIDKOSTYAM]
L. S. Sterman and V. V. Petukhov 15 Sep. 1967 18 p refs Transl. into ENGLISH from the book "Issledovaniya po Primeneniyu Organicheskikh Teplono-Siteley-Zamedliteley v Energeticheskikh Reaktorakh" Moscow, 1964 p 95–106
(FTD-MT-67-45; AD-668507)

The heat-transfer coefficients to monoisopropylbiphenyl and biphenyl during variations in the process parameters were determined, and the results were compared with theoretical equations of different types. These coefficients were determined during turbulent flow in tubes without a change in the state of aggregation of the organic fluids. The heat-transfer coefficients to monoisopropylbiphenyl were determined at heat fluxes of 200,000, 500,000, and 860,000 Kcal/sq m hr and at circulation rates of 4, 6, 10 and 15 m/sec., and those to biphenyl were determined at a heat flux of 300,000 Kcal/sq m hr and circulation rates of 4 and 6 m/sec. Under these conditions, the Reynolds number was found to fall within 25,000 - 420,000, and the heat-transfer coefficient varied from 3,000 to 18,000 Kcal/sq m hr deg. C. Author (TAB)

N68-26407# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HEAT EXCHANGE OF BODIES OF DIFFERENT FORM WITH TURBULENT FLOW OF AIR [TEPLOOBMEN TEL RAZLICHNOY FORMY S TURBULENTNYM POTOKOM VOZDUKHA]
Y. K. Shchitnikov 3 Aug. 1967 41 p refs Transl. into ENGLISH from the book "Teplo-i Massoobmena Tel s Okruzhayushchey Gazovoy Sredoy" Minsk, Izd. Mauka i Tekhn., 1965 p 86–111
(FTD-MT-67-74; AD-668096)

The article gives the results of an experimental investigation of convective heat transfer between a sphere, a cylinder, a cone, a disc, a slab, and a plate and a stream of turbulent air, including the effect of the orientation of the body in the air stream. The experiments were made under identical thermal and hydrodynamic conditions, at Reynolds numbers from 10,000 to 150,000. The degree of turbulence was 2.4%. The experimental bodies were made of sheet copper 0.0015 meters thick with their dimensions given in a table. The results were correlated by similarity theory. Author (TAB)

N68-26483# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN PROBLEMS OF GAS DYNAMICS OF STREAMS IN TRANSVERSE FLOW DURING BURNING [NEKOTORYYE VOPROSY GAZODINAMIKI STRUY V POPERECHNOM POTOKE PRI GORENII]
V. A. Kosterin, Ye. V. Rzhevskiy, and A. Ya. Khismatullin 10 Oct. 1967 16 p refs Transl. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Aviats. Tekhn. (Kazan), no. 1, 1966 p 130–139
(FTM-MT-24-303-67; AD-668156)

Results of experimental investigation of gas dynamics of a wake forming behind a fan stream in transverse flow of a uniform fuel-air mixture during burning are given in the article. The field of speeds, temperatures and pressures are studied. Analysis is made of results of tests in the form of generalized dependencies, and a comparison is given with data obtained without burning in the wake after the fan stream and axisymmetrical bluff body. Author (TAB)

N68-26485# Societa Ricerche Impianti Nucleari, Saluggi (Italy). Centro Ricerche Nucleari.
FORCED CONVECTION BURNOUT AND HYDRODYNAMIC INSTABILITY EXPERIMENTS FOR WATER AT HIGH PRESSURE. PART 4: BURNOUT EXPERIMENTS IN A DOUBLE CHANNEL TEST SECTION WITH TRANSVERSELY VARYING HEAT GENERATION
A. Campanile, G. Galimi, and M. Goffi Brussels EURATOM Feb. 1968 35 p refs
(Contract EURATOM-008-61-12 PNII)
(EUR-3881.E)

Experiments have been carried out on a complex geometry test section consisting of two heating rods coaxially mounted in two adjacent and communicating flow channels. Several conditions of differential heating in the two channels were tested to the aim of investigating the effect on burnout limits of possible variations of local flow velocity and fluid enthalpy due to transverse flow redistribution and mixing. Author (NSA)

N68-26520# Rocket Propulsion Establishment, Westcott (England).

PERCHLORIC ACID FLAMES: PART 8. METHANE-RICH FLAMES WITH OXYGEN

G. S. Pearson May 1967 20 p refs
(RPE-67/5)

The effect of adding oxygen to a very fuel-rich methane–perchloric acid flame has been examined. At sufficiently large additions of oxygen a second flame zone is established downstream of the first flame. Burnt gas compositions from the first flame have been measured for a range of oxygen additions. Most of the added oxygen reacts in the perchloric acid flame and results, probably indirectly, in the consumption of a further amount of methane. The second flame is shown to be a methane–oxygen flame. The results are discussed in the light of the mechanism previously proposed for methane-rich perchloric acid flames. Author

N68-26535# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ELECTROSIMULATION OF HEAT EXCHANGE IN HEAT EXCHANGERS OF THE REGENERATIVE TYPE [ELEKTROMODELIROVANIYE TEPLOOBMENA V TEPLOOBMENNIKAKH REGENERATIVNOGO TIPA]

V. P. Veselov and A. V. Temnikov 5 Sep. 1967 15 p refs Transl. into ENGLISH from Tr., Kuibyshevsk. Aviats. Inst. (Kuibyshev), no. 15, 1963 p 287–293
(FTD-MT-24-119-67; AD-668032)

The report considers a regenerative type heat exchanger of the most simple type. The mathematical problem of heat transfer in such a regenerator reduces to the solution of two partial differential equations. A mathematical method is presented for solution of these equations on an analog computer. Comparisons of the results of this simulation method with analytical solutions are shown in two figures. It is stated that the proposed method can be used also for investigation of heat transfer in a fixed bed of particle material, blown through by a stream of gas, and for investigation of the temperature of the heat transfer medium in countercurrent flow in a regenerator. The method is claimed to be sufficiently accurate for engineering purposes. Author (TAB)

N68-26551# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF A LONGITUDINAL MAGNETIC FIELD ON CONVECTION HEAT TRANSFER DURING TURBULENT FLOW OF A CONDUCTING FLUID IN A PIPE [EKSPERIMENTAL'NOYE ISSLEDOVANIYE ULIYANIYA PRODOL'NOGO NA KONVEKTIVNYY TEPLOOBMEN PRI TURBULENTNOM TECHENII ELEKTROPROVODNOY ZHIDKOSTI V TRUBE]

D. S. Kovner, Ye. Yu. Krasil'nikov, and I. G. Panevin 11 Aug. 1967 16 p refs Transl. into ENGLISH from Magnitn. Gidrodinamika (USSR), v. 2, no. 4, 1966 p 101–106
(FTD-MT-24-189-67; AD-668052)

The influence of a longitudinal magnetic field on convection heat transfer during turbulent flow of a conducting liquid in a pipe is studied, and an empirical formula for calculation of the heat transfer is subsequently offered. In general, at a constant Hartman number, the influence of the magnetic field decreases as the Reynolds and Peclet numbers increase. Author (TAB)

N68-26638*# Naval Weapons Center, China Lake, Calif. Michelson Labs.

DIFFERENCES BETWEEN THE COMBUSTION OF ALUMINUM DROPLETS IN AIR AND IN AN OXYGEN–ARGON MIXTURE

J. L. Prentice and L. S. Nelson (Sandia Corp., Albuquerque, N. Mex.) Oct. 1967 13 p refs
(NASA Order W-6032; Contract AT(29-1)-789)
(NASA-CR-94807; SC-DC-67-2295) CFSTI: HC $3.00/MF $0.65
CSCL 21B

When aluminum droplets were burned in air and its nitrogen-free analog, 20% O_2 in Ar, marked differences between the combustions appeared. The freely falling aluminum droplets were formed and ignited with single millisecond pulses from a Nd glass laser. Trajectories of aluminum droplets burning in air indicated vigorous spinning and showed jetting and fragmentation in the lower portion of the trace. In the nitrogen-free combustion, the trace was broader and somewhat shorter. The trace showed no sign of a spinning particle. The droplet that burned in 20% O_2–Ar fell considerably more slowly than the droplet that burned in air, and virtually stopped before extinguishment. When the droplets were allowed to impact glass at similar stages of combustion, marked differences again appeared. The droplet burned in the O_2–Ar mixture was a bare aluminum sphere surrounded by a circular smoke pattern. The droplet ignited in air showed a glass-like hemispherical cap attached to one side of the aluminum sphere and the smoke pattern was nonsymmetric. NSA

N68-26641*# Itek Corp., Palo Alto, Calif. Vidya Div.

AN ANALYSIS OF THE COUPLED CHEMICALLY REACTING BOUNDARY LAYER AND CHARRING ABLATOR. PART 3: NONSIMILAR SOLUTION OF THE MULTICOMPONENT LAMINAR BOUNDARY LAYER BY AN INTEGRAL MATRIX METHOD

Eugene P. Bartlett and Robert M. Kendall (Aerotherm Corp.) Washington NASA Jun. 1968 138 p refs Prepared jointly with Aerotherm Corp., Palo Alto, Calif.
(Contract NAS9-4599)
(NASA-CR-1062; Rept.-68-7, Pt. 3) CFSTI: HC $3.00/MF $0.65
CSCL 20M

A laminar nonsimilar boundary-layer procedure is described which yields accurate solutions for a broad range of problems. In its current formulation, solutions can be obtained for any equilibrium chemical environment with specified rate-controlled reactions at the surface. It has been used to treat a variety of ablating and nonablating surface boundary conditions including coupled energy and mass balances. The formulation considers unequal diffusion and thermal diffusion coefficients for all species in a particularly convenient manner through a bifurcation approximation for binary diffusion coefficients. The multicomponent viscosity and thermal conductivity of the mixture are determined by use of Sutherland–Wassiljewa type approximations. The procedure is readily applicable to inclusion of one-dimensional radiation emission and absorption and a general nonequilibrium chemical model. The procedure combines features of the general integral relations approach with those of matrix solution techniques. Following the former, smooth functions (in particular, cubic spline functions) are chosen to relate the principal dependent variables to their derivatives. Author

N68-26650*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

BODY ROTATION EFFECTS ON MELTING ABLATION

Thomas H. Cochran and Simon Ostrach (Case Inst. of Tech.) Washington Jun. 1968 40 p refs
(NASA-TN-D-4614) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The effects of rotation on the ablation of an axisymmetric body composed of a highly viscous material and subject to deceleration in an airstream were studied analytically and experimentally. The tests were conducted so that a parameter representing the importance of rotation effects and which was obtained from a nondimensionalization of the governing equations was varied from 0 to 4.2. The results indicate that, although rotation had no effect on the ablation process in the vicinity of the stagnation point of the body, significant changes in the character of the generated waves and in the flange were caused by rotation. Liquid was thrown from the body in the vicinity of the flange when the spin parameter was 0.88 or greater. Author

N68-26670# Ohio State Univ. Research Foundation, Columbus. Aeronautical and Astronautical Research Lab.
HEAT TRANSFER MEASUREMENTS IN HYPERSONIC LOW DENSITY FLOWS WITH PHASE CHANGE COATINGS Final Technical Report, Sep. 1964–Sep. 1967
Gerald M. Gregorek and John D. Lee Wright-Patterson AFB, Ohio ARL Jan. 1968 31 p refs
(Contract AF 33(657)-11060)
(ARL-68-0004; TR-5; AD-669084)

Aerodynamic heat transfer rates to blunt 10 and 25 degree cones were measured using surface coatings which change phase at precisely known temperatures. Results from motion picture time-histories of the melting of the coatings on nylon and teflon models taken at Mach 10 and Re sub infinity D = 5600 are compared with earlier experiments on thin-skin models using a transient technique. The two methods agree within 5% at heating rate levels below 1 BTU/sq ft sec but show 25% deviations at levels about 2 BTU/sq ft sec. This error is attributed to the injection procedure which made determination of the exact moment of model insertion difficult. Author (TAB)

N68-26682*# Itek Corp., Palo Alto, Calif. Vidya Div.
AN ANALYSIS OF THE COUPLED CHEMICALLY REACTING BOUNDARY LAYER AND CHARRING ABLATOR. PART 2: FINITE DIFFERENCE SOLUTION FOR THE IN-DEPTH RESPONSE OF CHARRING MATERIALS CONSIDERING SURFACE CHEMICAL AND ENERGY BALANCES
Carl B. Moyer and Roald A. Rindal Washington NASA Jun. 1968 142 p refs Prepared jointly with Aerotherm Corp., Palo Alto, Calif.
(Contract NAS9-4599)
(NASA-CR-1061; Rept.-66-7, Pt. 2) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An analysis of the in-depth response of materials exposed to a high temperature environment was presented, and a computer program based upon the analysis was described. The differential equations for the in-depth response are formulated and then cast into a finite difference form implicit in temperature. Three pyrolyzing constituents are allowed, with an accurate model of observed pyrolysis kinetics. Heat flow in-depth is one-dimensional, but cross-section area may vary with depth. The program for in-depth response computation may be coupled to a variety of boundary conditions. One of the possible boundary conditions is a complete boundary layer solution described in other reports of this series. Another version of the program may be coupled to a general film coefficient model of the boundary layer; this boundary condition is described in some detail in the present report. Author

N68-26759*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BOUNDARY CONDITIONS FOR THE DIFFUSION SOLUTION OF COUPLED CONDUCTION-RADIATION PROBLEMS
Marvin Goldstein and John R. Howell Washington Jun. 1968 42 p refs
(NASA-TN-D-4618) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The boundary condition for use with the diffusion solution for coupled radiation and conduction energy transfer is derived. An effective slip coefficient is presented as a function of the conduction–radiation parameter. Comparison to exact numerical solutions is good for the geometry of infinite parallel black plates. In the course of the analysis, a uniformly valid asymptotic expansion for the combined conduction and radiation problem in a nongray medium in the optically thick regime, and an exact analytical solution to the radiation-conduction transport equation in the boundary regime are obtained. Author

N68-26761# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
UNSTABLE CONVECTION HEAT EXCHANGE AND HYDRODYNAMICS IN CHANNELS. SURVEY OF LITERATURE ON SINGLE PHASE HEAT TRANSFER AGENTS [NESTATSIONARNYY KONVEKTIVNYY TEPLOOBMEN I GIDRODINAMIKA V KANALAKH. OBZOR LITERATURY PO ODNOFAZNYM TEPLONOSITELYAM]
E. A. Kalinin 31 Aug. 1967 28 p refs Transl. into ENGLISH from Vestsi Akad. Navuk Belarusk. SSR, Ser. Fiz.-Tekh. Navuk (Minsk), no. 4, 1966 p 1–22
(FTD-MT-24-188-67; AD-668159)

In this continuation of a survey of the published works of theoretical and experimental studies of unstable heat exchange and hydrodynamics in channels, the report reviews several preliminary mathematical formulas and criteria of the profiles of temperature and heat exchange, and attention is drawn to the relative paucity of theoretical and experimental studies in this area, both in the USSR and abroad. Author (TAB)

N68-26763# Sandia Corp., Albuquerque, N. Mex.
SPHERE 2: A TWO-DIMENSIONAL HEAT CONDUCTION AND TRAJECTORY COMPUTER PROGRAM FOR REENTRY HEATING OF SMALL SPHERICAL BODIES
C. B. Watkins Dec. 1967 55 p refs
(SC-RR-67-2996) CFSTI: HC $3.00/MF $0.65

The theory and numerical arialysis is given for a computer model which treats simultaneously the trajectory and two-dimensional heat transfer for a small reentering sphere. The associated computer program is presented along with instructions for its use. Author (NSA)

N68-26815*# Itek Corp., Palo Alto, Calif. Vidya Div.
AN ANALYSIS OF THE COUPLED CHEMICALLY REACTING BOUNDARY LAYER AND CHARRING ABLATOR. PART 4: A UNIFIED APPROXIMATION FOR MIXTURE TRANSPORT PROPERTIES FOR MULTICOMPONENT BOUNDARY-LAYER APPLICATIONS
Eugene P. Bartlett, Robert M. Kendall, and Roald A. Rindal Washington NASA Jun. 1968 57 p refs
(Contract NAS9-4599)
(NASA-CR-1063; Rept.-66-7, Pt. 4) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Self-consistent approximations for binary diffusion coefficients, multicomponent thermal diffusion coefficients and mixture viscosity and thermal conductivity are presented which greatly simplify the solution of multicomponent laminar boundary-layer problems. The basic premise of the approach is a bifurcation of binary diffusion coefficients, $D_{ij} = \bar{D}/F_iF_j$, where $\bar{D}$ is a reference diffusion coefficient and F_i is a diffusion factor for species i. The primary utility of the bifurcation approximation in multicomponent boundary-layer applications is that it enables explicit solution of the Stefan–Maxwell relations for the diffusive mass fluxes, j_i. The approximation for multicomponent thermal diffusion coefficients is based upon generalization of a semi-empirical equation for correlating binary

thermal diffusion data. Approximate relations for mixture viscosity and thermal conductivity of the Sutherland–Wassiljewa type are simplified by use of the bifurcation approximation for binary diffusion coefficients. Author

N68-26816*# Itek Corp., Palo Alto, Calif. Vidya Div.
AN ANALYSIS OF THE COUPLED CHEMICALLY REACTING BOUNDARY LAYER AND CHARRING ABLATOR. PART 5: A GENERAL APPROACH TO THE THERMOCHEMICAL SOLUTION OF MIXED EQUILIBRIUM–NONEQUILIBRIUM, HOMOGENEOUS OR HETEROGENEOUS SYSTEMS
Robert M. Kendall Washington NASA Jun. 1968 45 p refs
(Contract NAS9-4599)
(NASA-CR-1064; Rept.-66-7, Pt. 5) CFSTI: HC $3.00/MF $0.65
CSCL 20M

A general equilibrium and nonequilibrium chemical state procedure is developed and applied mathematically to a number of open and closed thermodynamic systems. The conventional equilibrium relations are developed in terms of a set of base species. The base species concept is then extended in order to treat mixed equilibrium and nonequilibrium systems in a general fashion. The specification of controlling reactions is used to create non-redundant equation sets as equilibrium is approached. The treatment of open system mass balances within the basic framework of the state solution permits direct surface state calculations considering boundary-layer transfer relations and surface-condensed phase removal relations. The computer program which performs the equilibrium state solutions according to the methods presented, the Aerotherm Chemical Equilibrium (ACE) program is described briefly. The program which contains some of the nonequilibrium features of the analysis, the ACE/KINET program is also introduced. Author

N68-26817*# Itek Corp., Palo Alto, Calif. Vidya Div.
AN ANALYSIS OF THE COUPLED CHEMICALLY REACTING BOUNDARY LAYER AND CHARRING ABLATOR. PART 6: AN APPROACH FOR CHARACTERIZING CHARRING ABLATOR RESPONSE WITH IN-DEPTH COKING REACTIONS
Roald A. Rindal Washington NASA Jun. 1968 48 p refs
(Contract NAS9-4599)
(NASA-CR-1065; Rept.-66-7, Pt. 6) CFSTI: HC $3.00/MF $0.65
CSCL 20M

The analysis of a charring ablation material which may undergo subsurface coking of the pyrolysis gas is considered. Coking reactions considered include thermal cracking of gaseous hydrocarbons resulting in precipitation of carbon onto the char layer and, at higher temperatures, the subsequent internal chemical erosion of the char structure by the gaseous pyrolysis products. A generalized type of ablation material is defined which consists of inert, carbon, and reactive constituents. Three types of subsurface reactions are considered, 1) decomposition of up to three organic constituents to form initial char and pyrolysis gas products, 2) kinetically controlled decomposition of the pyrolysis gas resulting in carbon precipitation and char desification, and 3) at high temperature, chemical erosion of the subsurface char matrix by the pyrolysis products according to the dictates of chemical equilibrium. A model is considered for evaluating the pressure distribution through the char layer of variable permeability. Differential equations are developed to represent the transfer of mass, energy, and momentun within the framework of the postulated phenomenological model. Author

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N68-25895# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.
POLITICAL AND TECHNICAL ALTERNATIVES FOR INTERNATIONAL SPACE PROJECTS
H. H. Koelle Sep. 1967 22 p Presented at the 18th Intern. Astronautical Congr., Belgrade, Sep. 1967
(TUB-IR-5/67) CFSTI: HC $3.00/MF $0.65

This paper discusses the probability and reasons for an increased cooperation in space on a truly international scale in the future. The political incentives for such cooperation as well as the economical advantages for the individual partners seem to warrant a closer look at the possibilities open to the space faring nations of this planet. Before such negotiations can take place, technical alternatives of likely candidates have to be analysed to determine their feasibility, the expected return, and the resources required. A model concerning the potentially available resources for international space projects is developed, which can be used to establish lower and upper limits for such efforts. A list of factors is presented which very likely will influence international cooperation as well as the magnitude of such a program in the decades to come. This is followed by a list of candidate projects of interest for the remainder of this century, ranked in order to preference by applying suitable selection criteria. Structure and management problems of a typical program are discussed. Author

N68-25922# Congress. Senate. Committee on Aeronautical and Space Sciences.
NASA AUTHORIZATION FOR FISCAL YEAR 1969. PART 3: NUCLEAR ROCKETS PROGRAM
Washington GPO 1968 241 p Hearings Before Comm. on Aeron. and Space Sci., 90th Congr., 2d Sess., 24, 25 and 30 Apr. 1968
GPO: HC $1.25; CFSTI: MF $0.65

Supporting testimony is presented on behalf of the joint NASA–AEC space nuclear propulsion program. The development status, the objectives, the capabilities, and the role of the NERVA engine in the national space program are reviewed, as a basis for making the decision to provide the financial support needed to develop a flight engine in the 70,000 pound thrust class. Funding by both agencies is detailed. Mission versatility of a nuclear vehicle is discussed in relation to planned space programs and the compatibility of the NERVA engine with the Saturn 5 launch vehicle system. The need for a long leadtime in nuclear propulsion technology is stressed, along with the importance of nuclear rocket development in keeping the United States preeminent in space. M.G.J.

N68-26031# Technische Univ., Berlin (West Germany).
THE MEANING OF SPACE PROGRAMS FOR THE POSITION OF A NATION IN THE WORLD COMMUNITY [DIE BEDEUTUNG DER RAUMFAHRT FUER DIE STELLUNG EINES STAATES IN DER VOELKERGEMEINSCHAFT]
H. H. Koelle 10 Apr. 1968 36 p refs In GERMAN Presented at WGRR/WGLR Ann. Meeting, Bad Godesberg, West Ger., 1968
(TUB-IR-3/68; Rept.-68-029) CFSTI: HC $3.00/MF $0.65

The author discusses the importance of space travel research and technology and especially its impact on Germany. He concludes that space travel is of utmost and far reaching value for a country's position in the world community and advocates a ranking matrix to quantitatively analyze the economic aspects of Germany's participation in an international space travel program. Transl. by G.G.

N68-26072# Technische Univ., Berlin (West Germany). Institut fuer Raumfahrttechnik.
SOCIO-ECONOMIC MODEL OF THE PLANET EARTH [SOZIO-OEKONOMISCHES MODELL DES PLANETEN ERDE] Interim Report
H. H. Koelle 1 Jun. 1966 39 p refs In GERMAN
(TUB-IR-2/1966) CFSTI: HC $3.00/MF $0.65

Described is an attempt to devise a mathematical model for the quantitative measurement of civilization on Earth which considers man as well as his environment. Eight areas of civilization are established and 81 measurable values are assigned to the areas. These values are converted into weighted functions resulting in a quantitative expression for present and past conditions. The validity of the model is tested by applying it to conditions in the United States and the Federal Republic of Germany for the period 1950 to 1970. The results of this model study are presented and improvements are discussed. The purpose of the model is to enhance understanding of socio-economic conditions on Earth and to serve as a tool in judging political and economic alternatives.
Transl. by K.W.

N68-26250# Carnegie-Mellon Univ., Pittsburgh, Pa. Management Sciences Research Group.
MULTI-DIMENSIONAL AND DYNAMIC ASSIGNMENT MODELS WITH SOME REMARKS ON ORGANIZATION DESIGN
A. Charnes (Northwestern Univ.), W. W. Cooper, and A. Stedry Mar. 1968 24 p refs Prepared jointly with Northwestern Univ. *Its* Management Sci. Res. Rept. No. 124
(Contracts Nonr-760(24); N00014-67-C-0173; Nonr-1228(10); DA-31-124-ARO(D)-322)
(AD-668326)

The assignment model of linear programming is here extended to allow for dynamic interactions between assigned personnel and positions in each of a variety of possible measures and approaches are explored. These extensions are accompanied by additional remarks and interpretations which are intended to point toward further possible developments that might ultimately open avenues for new approaches to organization design and personnel placement.
Author (TAB)

N68-26272# California Univ., Los Angeles. Western Management Science Inst.
ECONOMICS OF INQUIRING, COMMUNICATING, DECIDING
Jacob Marschak Jan. 1968 36 p *Its* Working Paper No. 134
(Contract Nonr-233(75))
(AD-668496)

The demand price of various informational (i.e., symbol-manipulating rather than matter-transforming or matter-transporting) instruments or services depends on the expected payoff they can earn for their users. Certain statistical characteristics such as Blackwells informativeness of inquiries and Shannons capacity of a transmission channel are examined as to their effect on the payoff to a given user; and the special character of the underlying assumptions is pointed out. As regards the supply price, and thus the cost, of informational services (i.e., of inquiry, coding, transmitting, deciding), a sketch is made of the current incomplete knowledge of comparative advantages of men vs. machines with respect to particular kinds of services; and of certain economies of mass production. An understanding of the factors determining the demand, the supply, and the market prices of informational services is needed for any discussion of the welfare economics of information, and thus of economic policies relevant to education and research.
Author (TAB)

N68-26275# Defense Dept., Washington, D. C. Office for Laboratory Management.
EFFECTIVE USE OF FEDERAL LABORATORIES
Donald M. MacArthur 2 Apr. 1968 31 p refs
(MAM-68-6; AD-668344)

In the general discussion on how to make the best use of existing Federal laboratories, the following issues are explored: how to use or redirect a laboratorys capabilities when it essentially has completed its assigned mission; what policies or procedures foster or hinder an agency of Government making use of the capabilities existing in a laboratory funded by another agency; how can, or should, mission-oriented laboratories be responsive to national problems -- such as transportation, housing or crime -- in which they may have a capability; to what extent should laboratory directors have funds available to respond to new areas of opportunity, and what guidelines are there to determine if new laboratories should be created to respond to new missions or if the job can be handled within existing laboratories.
Author (TAB)

N68-26605*# Southeastern State Coll., Durant, Okla. Technology Use Studies Center.
TECHNOLOGY UTILIZATION IN A NON-URBAN REGION: THE FIRST FOUR YEARS OF AN EXPERIMENT Final Report
Lee B. Zink May 1968 155 p
(Contracts NASr-178; NSR-37-004-006)
(NASA-CR-95099) CFSTI: HC $3.00/MF $0.65 CSCL 05C

A four year experimental program designed to identify opportunities for local industry use of NASA developed technology is discussed. Described are some the problems that were encountered in establishing the base for effective technology transfer, and development of means by which the information could be most effectively disseminated. Included are examples of some of the specific transfer projects conducted during the experiment, as well as a tentative evaluation of the overall success of the program.
A.L.

N68-26739*# Indiana Univ. Foundation, Bloomington. Aerospace Research Applications Center.
REPORT OF THE NATIONAL CONFERENCE ON TECHNOLOGY UTILIZATION AND ECONOMIC GROWTH
Charles W. Mullis, ed. 1967 308 p refs Conf. held at Bloomington, Ind., 4 Aug.–30 Jul. 1967; Sponsored by NASA and Dept. of Commerce
(Grant NSR-15-003-055)
(NASA-CR-94804) CFSTI: HC $3.00/MF $0.65 CSCL 05C

The relationship between the rate of utilization of already developed technology and the rate of national economic growth was the focal point of interest during the conference. The multidisciplinary problems involved were reflected in assessments of the roles that must be assumed by business schools, engineering schools, Federal Government programs, research institutes, and business firms in effecting technology transfers and assuring a return on expenditures for R&D. Consideration was also given to the increasing applications of technology in such areas as urban administration, financial institutions, medical sciences, and education. The impact of the space program on the domestic economy, and on management and economic growth in general, is examined in terms of employment, wages, and productivity. Technology transfer techniques are evaluated, and the facilities for disseminating information are discussed.
M.G.J.

N68-26753*# Pennsylvania Univ., Philadelphia. Dept. of Regional Science.
PHILADELPHIA REGION INPUT–OUTPUT STUDY WORKING PAPERS
Walter Isard, Thomas W. Langford, Jr., and Eliahu Romanoff [1968] 464 p refs
(Grant NsG-497)
(NASA-CR-95093) CFSTI: HC $3.00/MF $0.65 CSCL 05C

As a basis for regional economic impact analysis, a highly detailed input–output study of the Philadelphia region was conducted to determine the possible effects of various changes in federal programs and expenditure patterns. Long questionnaires were designed to obtain data on the input structure of the establishment; the geographic origin and destination of purchases and sales; and the proportion of sales to defense-related agencies. These procedures pertained mainly to manufacturing, mining and

construction industries. The methods used for surveying non-manufacturing and community services are also described. The procedures used for estimating the structural coefficients for each sector and for determining the output estimates are detailed. Preliminary input–output coefficient tables are presented. M.G.J.

N68-26754*# Pennsylvania Univ., Philadelphia. Regional Science Research Inst.

PHILADELPHIA REGION INPUT–OUTPUT STUDY WORKING PAPERS. VOLUME 3: FINAL DEMAND

Walter Isard and Thomas W. Langford, Jr. [1968] 157 p refs

(Grant NsG-497)

(NASA-CR-95092) CFSTI: HC $3.00/MF $0.65 CSCL 05C

The development of one set of input–output coefficient estimates for 86 final demand sectors is described. Details are given on the methodology used to obtain data on personal consumption expenditures, private investment expenditures, and expenditures of the Federal military and civilian agencies, and regional export–import estimates. Also included are input–output coefficient tables which present the sector data in matrix form. M.G.J.

N68-26813*# Boeing Co., Seattle, Wash.

STUDIES OF COST EFFECTIVE STRUCTURES DESIGN FOR FUTURE SPACE SYSTEMS—SUMMARY Final Report, 17 Oct. 1966–17 Oct. 1967

Bruce Allesina and E. F. Styer Washington NASA Jun. 1968 158 p refs.

(Contract NAS7-525)

(NASA-CR-1068; D2-114116-1) CFSTI: HC $3.00/MF $0.65 CSCL 14A

The application of economics to aerospace design problems is discussed. The three major goals were: to define promising directions for structural research by applying the concept of minimum cost rather than maximum performance to structural design; to understand the relationship of the structure to the economics of the total system; and to identify and apply the interactions of the various aspects of program costs to point out the potential cost savings they imply. All goals were satisfied and some of the conclusions reached were: (1) Cost considerations should be employed early in a program. (2) A concerted program of cost data collection, economic methods development, and industry education in use of cost as a design criteria is required. (3) Proper balance should be established between costs and weights for design candidates at the part, subsystem, and systems level. (4) Sophistication in low earth orbit payloads should be de-emphasized, with more emphasis placed on use of larger launch vehicles. (5) Space program testing philosophy should be defined on a cost effective basis, measured against mission risk. A.L.

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